Chapter 5. Current Condition of the Species Covered or Addressed in the HCP

5. Current Condition of the Species Covered or Addressed in the HCP

The species that are covered or addressed in this Habitat Conservation Plan (HCP) were defined in Chapter 3. This chapter presents the current condition of the species and their habitats in the Sandy River Basin, including information on life histories, distribution and abundance, habitat needs, and threats to survival. As in Chapter 3, the species are divided into three general categories: fish, including covered species and other fish species; amphibians and reptiles; and birds and mammal.

5.1 Fish Species Selected for HCP Coverage

The Sandy River Basin supports a diverse assemblage of native and introduced fish species from its headwaters to its mouth. The native fish species include Chinook (fall and spring run), coho salmon, and steelhead.[1] These four species are the primary focus of the HCP, and there is good information available to describe their habitat needs and current status, as detailed in the following subsections. The other native fish species covered under the HCP are chum salmon and eulachon. Less information is available about chum and eulachon, which necessitated a different analysis approach. Table 3-1 lists the other aquatic species covered under the HCP and their state and federal Endangered Species Act (ESA) status.

Chinook salmon and winter steelhead were selected for coverage because they have been listed as threatened under the authority of the federal ESA. Lower Columbia River (LCR) Chinook (*Oncorhynchus tshawytscha*) were first listed in March 1999 and that ruling was reaffirmed in June 2005. Both the fall and spring races of Chinook that utilize the Sandy and Bull Run rivers are listed threatened species. LCR steelhead (*O. mykiss*) were first listed as a threatened species in March 1998, and that ruling was reaffirmed in January 2006. The LCR steelhead distinct population segment (DPS) was also identified in the January 2006 determination.

Coho salmon (*O. kisutch*) were included as covered species because of both state and federal analyses and decisions. In 2000, the Oregon Department of Fish and Wildlife (ODFW) listed LCR coho salmon as endangered under the state's Endangered Species Act.[2] LCR coho were listed as a federally threatened species in June 2005.

Columbia River chum (*O. keta*) were listed as a threatened species in March 1999. Most chum in the lower Columbia River prefer habitats in the mainstem Columbia. However, it is believed that the species could also use the lower Sandy River in the vicinity of the areas that will be affected by some of the City's HCP measures. For those reasons, the City decided to include chum salmon as a covered species.

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[1] Fall and spring Chinook are separate races of the same species *(O. tshawytscha)*. In this HCP, the City refers to them as two species. Fall and spring Chinook, steelhead, and coho are therefore referred to as the four primary species.

[2] The state of Oregon has listed some salmonid fishes under the state Endangered Species Act. However, that law applies only to actions of state agencies on state-owned or state-leased lands.

Pacific eulachon (*Thaleichthys pacificus*) was designated as a candidate species in March 2008. Eulachon, or smelt, are endemic to the eastern Pacific Ocean with a major and consistent spawning run in the mainstem Columbia River. In some years, eulachon spawn in the lower Sandy River in the vicinity of the area that will be affect by some of the City's HCP measures. Consequently, the City will include eulachon as a covered species.

5.2 Other Fish Species Addressed in the HCP

Other fish species addressed in this HCP include cutthroat trout, rainbow trout, Pacific lamprey, brook lamprey, and river lamprey. All of the fish species addressed in this HCP will benefit from the implementation of the measures for the primary covered species (fall and spring Chinook, winter steelhead, and coho salmon). Less is known about the other aquatic species in the Sandy River Basin. The available biological information for each species is summarized in this chapter.

Resident rainbow trout have the same scientific classification as steelhead and similar habitat requirements. Rainbow trout occur throughout the Sandy River watershed, including the two Bull Run reservoirs. Rainbow trout might be affected by both the City’s water supply operations and implementation of the HCP conservation measures.

Coastal cutthroat trout (*O. clarki clarki*) was proposed for listing in March 1999 but was never officially listed for several reasons (U.S. Fish and Wildlife Service [USFWS] 2002):

- The states of Oregon and Washington took steps to reduce mortality caused by direct and incidental harvest and to reduce hatchery production of anadromous life history forms in the lower Columbia River.
- Local conservation and recovery work and changes in forest management regulations reduced the risks to the species.
- The latest information indicated that there were relatively healthy-sized total populations in a large portion of the DPS.
- USFWS gained an improved understanding of the ability of freshwater forms to produce anadromous progeny.

Nevertheless, cutthroat trout remain a species of interest in the Sandy River Basin.

Three lamprey species will benefit from the HCP measures: Pacific lamprey (*Lampetra tridentata)*, western brook lamprey (*L. richardsoni*), and river lamprey (*L. ayresi*)). Pacific lamprey were listed as an Oregon state sensitive species in 1993 and were given further legal protection status by the state in 1996. Less information exists for western brook or river lamprey, but ODFW suspects these two fish have declined precipitously in recent decades (ODFW 2002). All three lamprey species could use habitat in the Bull Run and Sandy rivers.

5.3 Tools Used to Investigate Current Conditions for the Primary Covered Species

In addition to current research and publications, three tools were used to investigate current conditions for the species listed as endangered under the ESA: periodicity tables, the Ecosystem Diagnosis and Treatment (EDT) model, and the Physical Habitat Simulation (PHABSIM) model. Periodicity charts show the periods during the calendar year when fish are present in a particular life stage. The EDT model compares current conditions with estimated historical conditions. The PHABSIM model estimates the weighted usable area for spawning and rearing from the amount of flow in a stream.

Note: The HCP relies on the best and most complete data available at the time the document was drafted. In most cases, these data are from 2003. The City's understanding is that NMFS will use the most current available data about the species, including recovery planning documents, when evaluating the adequacy of the HCP.

5.3.1 Periodicity Charts

The periodicity charts for fall and spring Chinook, coho salmon, and steelhead in the Sandy River Basin were developed by the Sandy River Basin Agreement Technical Team (SRBTT) in December 2002. The figures were derived from several periodicity tables, including:

- Portland General Electric's (PGE's) ESA draft consultation documents related to their dam decommissioning process
- Oregon Department of Environmental Quality's (ODEQ's) draft total maximum daily load documents for the Sandy River Basin
- ODFW's 1997 Sandy River Fish Management Plan
- Portland Water Bureau's draft periodicity tables for the lower Bull Run River

5.3.2 EDT Modeling

The EDT model compares current conditions with historical conditions to determine

- which habitat attributes (called Level 2 environmental attributes in EDT) have degraded or improved over time.
- the relative effect each attribute has had on species performance across its historical distribution in the Sandy River Basin.
- the limiting factors (named Level 3 survival factors in EDT) for the species in the Sandy River Basin.

Historical conditions are defined as those existing prior to European settlement.

The EDT model expresses the interaction of 46 habitat attributes as the limiting factors that most affect a particular life stage. For example, the primary attribute that influences the spawning life stage as key habitat is the quantity of small cobble/gravel riffles. However, in the fry colonization stage, the amount of backwater pool habitat is the primary influence.

The SRBTT, from August through December 2000, entered all habitat data for each stream reach of the Sandy River Basin. Appendix B shows each stream reach length in miles and river miles. These data were used to create the habitat attribute ratings that are in the EDT model.

The first EDT modeling results for the Sandy River were completed in 2001. The model has been updated since then as new information about mortality influences, fish distribution, and other information became available. The limiting factors for each species are presented for watersheds for the Sandy River Basin from analyses using the EDT model. In addition, a matrix of limiting factors is provided for individual reaches in the Bull Run River watershed. Both show the potential effects of limiting factors as dots of different sizes. The dots represent EDT model estimates of the degree of habitat change from historical to current conditions. The values assigned to the dots differ for the Sandy River Basin and the reaches in the Bull Run watershed. The different scales are explained below.

Limiting Factors in the Sandy River Basin

The limiting factors in the Sandy River Basin are expressed as the degree to which species survival is reduced under current habitat conditions compared with historical conditions. Dots of different sizes show the estimated reductions in survival for each species by watershed. An empty cell shows a less than 1 percent change from historical conditions. The scale of the degree of change from historical to current conditions is shown in Figure 5-1 below.

Percentage change from historical conditions	Worse
Less than 1%	
Between 1 and 5%	•
Between 5 and 20%	●
More than 20%	⬤

Figure 5-1. Scale for Limiting Factors in the Sandy River Basin Watersheds

Limiting Factors in the Bull Run Watershed

EDT model results for Bull Run are shown for the life stages of each species. The numbers in the "life stage most affected" columns show the top three most affected life stages in the reach.[3] The most affected life stages are those that would be most accountable for the overall decline in species productivity in that reach. The numbers rank the accountability for the decline in productivity from 1, most accountable, to 3, least accountable.

The dots compare the life-stage survival under current conditions to survival under historical conditions for the attribute. The dot size indicates the proportional reduction or

[3] EDT models habitat conditions in reaches of the Bull Run watershed in which the species are not present (such as reaches above Dam 2) to determine the expected relative use of the reach by each life stage.

improvement in survival of the life stage indicated as the number 1 life stage most affected. An empty cell indicates negligible change (less than 0.2 percent) from historical conditions.

The scale of the degree of change from historical to current conditions is shown in Figure 5-2, below.

Percentage change from historical conditions	Worse	Better
Less than 0.2 %		
Between 1.0 and 0.2%	•	∘
Between 5 and 1%	●	○
Between 25 and 5%	●	○
More than 25%	●	○

Figure 5-2. Scale Explanation for Limiting Factors in the Bull Run Watershed

For example, in Figure 5-3, the dots under channel stability, competition from species, flow, food, habitat diversity, and key habitat diversity indicate the degree to which current conditions are worse than (solid circles) or better than (open circles) historical conditions for the fry colonization life stage. The circles for flow, food, and habitat diversity indicate that current conditions are between 5 and 25 percent worse than historical conditions. The circle for key habitat quantity indicates that current conditions are between 5 and 25 percent better than historical conditions.

	Life Stage Most Affected													Limiting Factors															
	Spawning	Egg incubation	Fry colonization	0-age migrant	0-age active rearing	0,1-age inactive	1-age migrant	1-age active rearing	2+-age active rearing	2+-age migrant	2+-age transient rearing	Prespawning migrant	Prespawning holding	Channel stability	Chemicals	Competition (w/hatch)	Competition (other species)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Bull Run Bear 1		2	1			3								●			•	●	●	●									○

Figure 5-3. Sample Matrix for Coho

The effects represented by the dots are weighted according to the expected relative use of the reach by each life stage (as if the species were present in the reach). For example, rearing juvenile steelhead are more affected by water temperature than are migrating steelhead smolts. If reach A has the potential to provide habitat for more rearing juveniles than reach B, the dot size under temperature will be larger for reach A than for reach B. However, if reach C has the potential to support only a few rearing juveniles and no emigrating smolts, and reach D cannot potentially support rearing juveniles but can provide habitat for large numbers of smolts, reaches C and D might have the same dot size under temperature.

Appendix D, EDT Information Structure, provides an introduction to the EDT model as well as tables with definitions of the habitat attributes, the limiting factors, and how habitat attributes are combined to estimate limiting factors. For more information on the EDT model and definitions of the limiting factors, see Appendix D, or Lestelle et al. 2004; City of Portland Bureau of Water Works 2004a; and Lestelle et al. 1996.

5.3.4 PHABSIM Modeling

R2 Resource Consultants (1998) used the PHABSIM model to estimate the habitat-flow relationships of the HCP measures on spawning and juvenile rearing habitat in the lower Bull Run River. The results are expressed as weighted usable area (WUA), an index of available instream habitat at various increments of flow. Using median flows up to 500 cubic feet per second (cfs) for segments of the lower Bull Run River, R2 Resource Consultants determined WUA estimates for natural flow conditions (no dams and no diversions) and estimates of HCP flows, both upstream and downstream of the Little Sandy River. For flows greater than 500 cfs, goodness-of-fit curves were used to extrapolate WUA values.

5.4 The Covered Species

The four primary covered fish species are fall Chinook, spring Chinook, winter steelhead and coho. The additional covered fish species are chum and eulachon.

5.4.1 The Four Primary Covered Species

Among fish species, the species listed under the ESA—Chinook (fall and spring races), steelhead, and coho—are the primary focus of attention for the HCP.[4] For these primary covered fish species, conditions are first described for the entire Sandy River Basin and then for the Bull Run River watershed. Information about current conditions for the other species is limited and is described primarily at the Sandy River Basin scale.

The topics covered under the Sandy River Basin and Bull Run subsections differ slightly, as shown below:

Sandy River Basin	**Bull Run Watershed**
Life history and diversity	Distribution
Distribution	Abundance
Abundance	Habitat conditions
Hatchery production and plantings	Limiting factors
Harvest in the basin	Flow and habitat preferences
Reasons for listing and/or threats to survival	

The status of salmonids in the Sandy River Basin is monitored by both the National Marine Fisheries Service (NMFS) and ODFW. This HCP uses reports and documents published by NMFS and ODFW, as well as EDT modeling results, as source information for reasons for decline and limiting factors for the species in the Sandy River Basin.

Because the Bull Run watershed is a subregion of the Sandy River Basin, some overlap between reasons for listing or limiting factors may occur between the larger Basin and the Bull Run watershed.

[4] Fall and spring Chinook are separate races of the same species (*O. tshawytscha*). In this HCP, the City refers to them as two species. Fall and spring Chinook, steelhead, and coho are therefore referred to as the four primary species.

Fall Chinook in the Sandy River Basin

Life History and Diversity

Fall Chinook salmon (*O. tshawytscha*) in the Sandy River Basin are included in the Lower Columbia River Evolutionarily Significant Unit (ESU) and in 1999 were listed as "threatened," under the federal ESA (NMFS and USDFWS 1999). Adult fall Chinook salmon begin to enter the Sandy River Basin in August and are probably present through February in small numbers. Peak spawning occurs from October through December, and spawning distribution appears to be controlled by flow conditions in the Basin (ODFW 1997). Estimated periods of occurrence of fall Chinook life stages in the lower portion of the Sandy River Basin (below the Marmot Dam site) are shown in Figure 5-4.

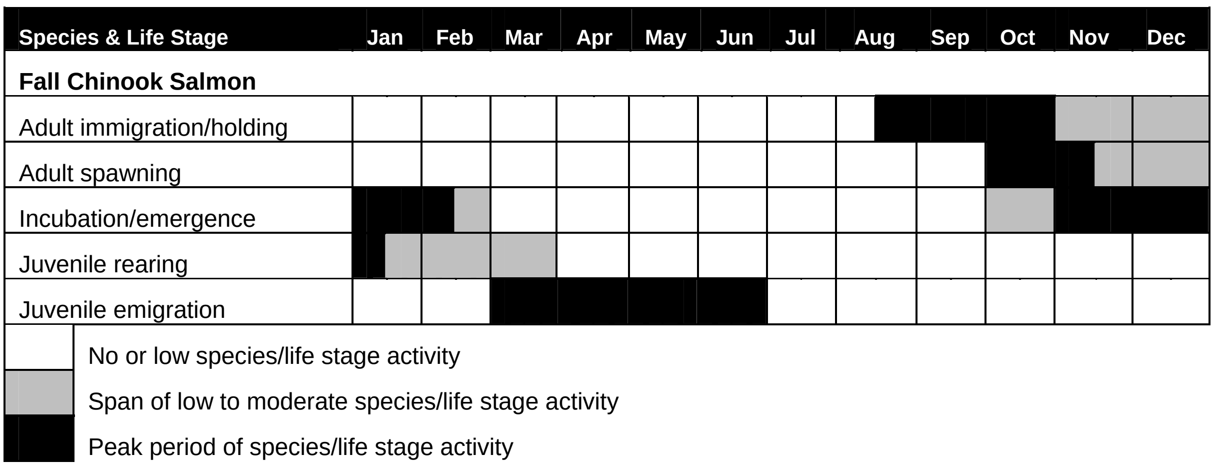

Figure 5-4. Estimated Periods of Occurrence for Fall Chinook in the Lower Sandy River Basin Below Marmot Dam Site

Source: Sandy River Basin Agreement Technical Team 2002.

Historically, fall Chinook were distributed in the Basin upstream to the Salmon River. They are now assumed to be present only below the Marmot Dam site.

Fall Chinook salmon in the Sandy River Basin are ocean-type fish, meaning they typically spend one year or less rearing in fresh water (NMFS 2003). Ocean-type Chinook salmon juveniles migrate to the ocean in the late summer or autumn of their first year as fry or fingerling migrants (Myers et al. 1998). If environmental conditions are not conducive to subyearling outmigration, however, ocean-type Chinook salmon juveniles may remain in fresh water for the entire first year after hatching (Myers et al. 1998; NMFS 2003).

Juvenile fall Chinook salmon are dependent on estuaries and their associated wetlands as nurseries before they migrate to the open ocean. Wetlands play a vital role in providing feeding opportunities and offering protection from predators. Juvenile Chinook salmon often rear up to six months in estuarine environments before spending the majority of their life in the ocean. Ocean residence varies, but most Chinook salmon spend between three and four years in saltwater before returning to spawn in fresh water.

Size, age, and run timing of adult fall Chinook vary by stock in the Sandy River Basin. ODFW currently recognizes two run components. The first, an early maturing tule stock, is also referred to as the lower river hatchery (LRH) stock. The second, the late maturing Lower River Wild (LRW) stock, shows run timing and genetic characteristics similar to the late wild stock in the Lewis River in Washington (NMFS 2003).

The early maturing tule fall Chinook are believed to be a mix of three groups: naturally produced fish that originated from hatchery releases made in the Sandy River prior to 1977; the progeny of successful spawning stray hatchery fall Chinook; and, to a lesser extent, stray hatchery fall Chinook adults originating from hatcheries in both Washington and Oregon (ODFW 1997). Tule fall Chinook begin entering the Sandy River in August, and spawning occurs in late September through mid-October. ODFW established the early maturing tule fall Chinook population as a component of the Tule Gene Conservation Group.

The late maturing LRW stock is indigenous to the Sandy River Basin and typically enters the Sandy River in October, with spawning occurring from late October through December. An additional component to the LRW stock is referred to as the Winter or Late Bright stock. The winter Chinook stock typically returns from December to early February. Recently, ODFW included the winter Chinook stock as a subcomponent of the Sandy River LRW stock (ODFW 1997). Together, they form the Sandy Fall Chinook Gene Conservation Group as established by ODFW.

The NMFS Willamette/Lower Columbia Technical Recovery Team (WLC-TRT) classified the late-run Sandy River brights (LRW stock) as both a “core” and a “genetic integrity” population in their recovery planning efforts. These designations mean that the population historically was abundant and productive; the current population resembles the historical life histories and genetic types in the Sandy River Basin; and the population currently offers one of the most likely paths to recovery in the Lower Columbia Chinook ESU (McElhany et al. 2003). Two states, Washington and Oregon, are preparing plans to address recovery in the Lower Columbia Chinook ESU. The Lower Columbia River Fish Recovery Board (LCRFRB), which is a Washington group, determined the priority for contribution of this stock to recovery goals in the ESU as “primary.” This classification means the Sandy River late fall Chinook stock is targeted for recovery as one of the stocks desired to achieve viable population levels with a greater than 95 percent probability of persistence (negligible extinction risk) within 100 years (LCRFRB 2004; McElhany et al. 2003; McElhany et al. 2004). Oregon is now in the process of developing a Lower Columbia River recovery plan for streams in Oregon.

The early fall run tule stock (LRH) did not receive a similar designation as either a core or genetic integrity population. The LCRFRB designated the priority for contribution of this stock to recovery goals as “stabilizing,” which focuses on maintaining the current population structure of this stock (LCRFRB 2004).

Distribution

The SRBTT developed a completed list of the reaches in which each natural population of anadromous salmonids was known or assumed to spawn, either currently or historically (City of Portland 2004a). For streams in which data were not available to determine species use, the SRBTT assumed that Chinook (spring and fall) would not utilize streams with a minimum width less than 15 feet or a gradient higher than 8 percent. After initial EDT model runs were completed in 2001, the SRBTT met again to review the results and re-examine spawning distribution in the Sandy River Basin. Based on this review, several spawning reaches were excluded for some species and added for others. This distribution information was used to develop Figures 5-5 and 5-6.

Current. The SRBTT determined the current fall Chinook distribution in the Sandy River Basin, as shown in Figure 5-5. Because fall Chinook were not observed upstream of Marmot Dam in the years prior to 2006, the SRBTT determined that the species is concentrated primarily in the mainstem Sandy River below the Marmot Dam site. The current distribution has probably been affected by several factors, such as ineffectiveness of the Marmot Dam fish ladder (from about 1913 to 1933), seasonal low flows in the Sandy River below Marmot Dam and in the Bull Run River, and ODFW egg-taking at Marmot Dam.

Available spawning habitat for tule fall Chinook is usually limited by low flow conditions characteristic of the Sandy River in early fall. Spawning generally occurs in the mainstem from Lewis and Clark State Park to the upstream boundary of Oxbow Park (ODFW 2002). Spawning may have occur in tributaries and side channels downstream of Marmot Dam if significant early season rainfall occurred.

Sandy River LRW fall Chinook utilize much of the same spawning habitat as tule fall Chinook, but due to their run timing they usually have more tributary and side-channel habitat available for spawning. For instance, Gordon and Trout creeks are important lower Basin tributaries used for fall Chinook spawning when flows increase (ODFW 2002).

Historical. The historical fall Chinook distribution assumed in the Sandy River Basin is shown in Figure 5-6. Though most spawning of fall Chinook now occurs in the mainstem and tributaries of the lower Basin near Oxbow Park, historical spawning distribution occurred both in the Bull Run River and above the Marmot Dam site in the Salmon River and Sixes Creek, a Salmon River tributary (ODFW 2002).

A table of current and historical distribution for all species and all watersheds in the Sandy River Basin is available as Appendix C.

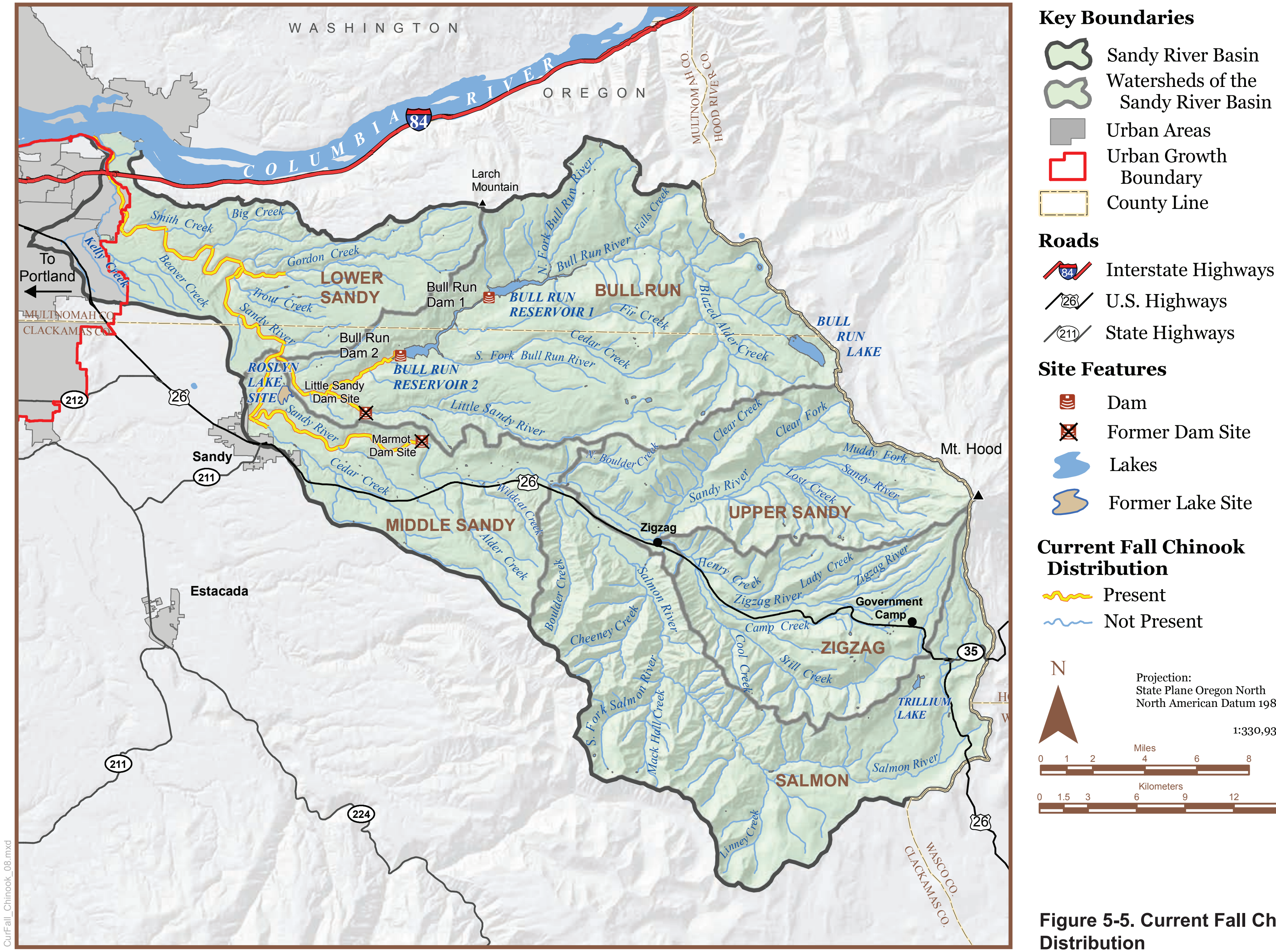

Figure 5-5. Current Fall Chinook Distribution

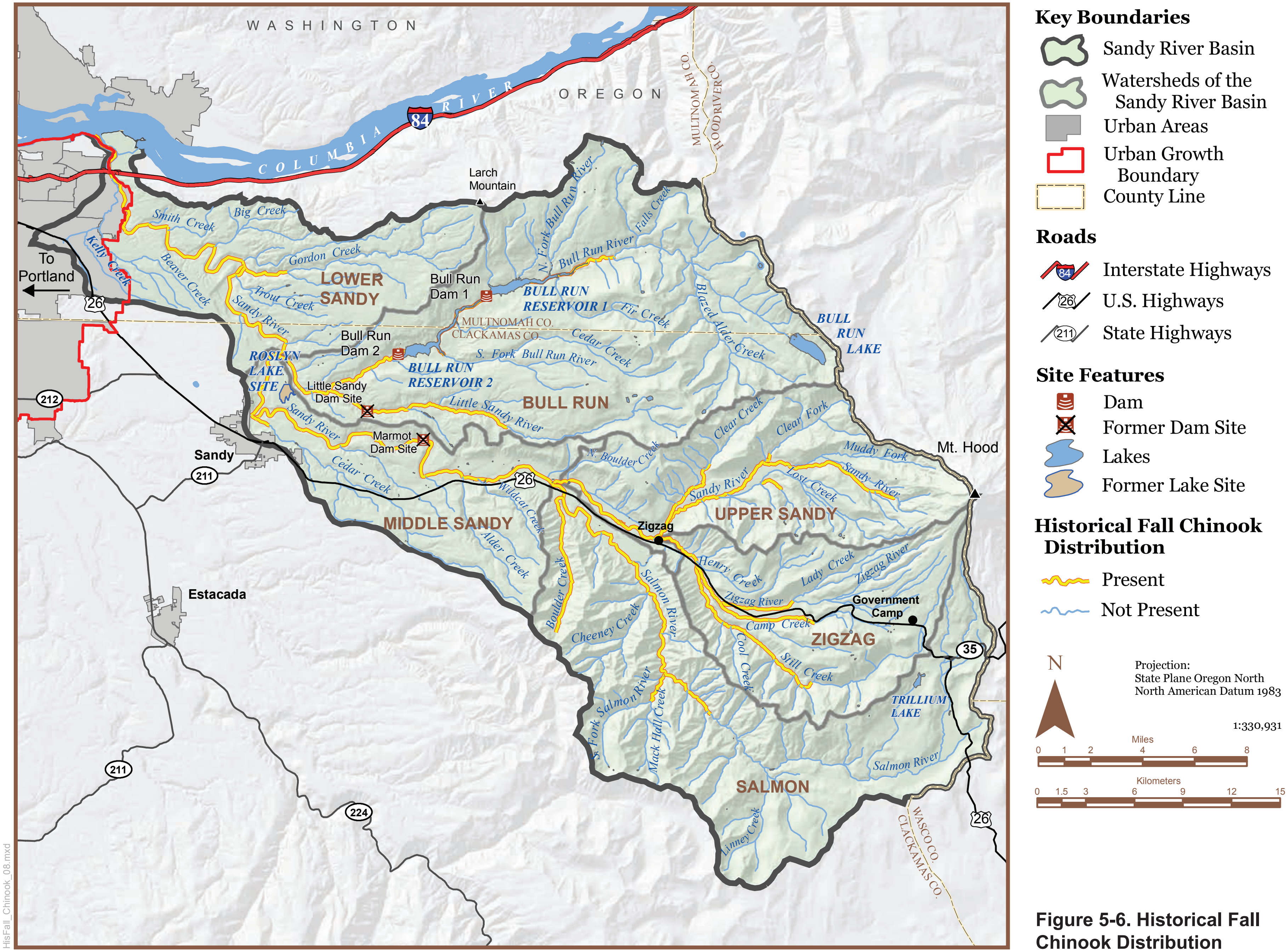

Figure 5-6. Historical Fall Chinook Distribution

Anchor Habitat. The Sandy River Basin Working Group (SRBWG), which is composed of agencies and nongovernmental groups interested in restoring fish runs in the Sandy River watershed, has identified anchor habitats for salmon and steelhead populations (SRBWG 2006). Anchor habitats are defined as distinct stream reaches that currently harbor specific life-history stages of salmon and steelhead to a greater extent than the stream system at large. Anchor habitats are usually not at capacity for fish production; they are areas that currently have the greatest fish densities. The SRBWG identified anchor habitat by evaluating empirical data, professional judgment data, and EDT model data of current conditions. The SRBWG believes a successful habitat restoration strategy for the Sandy River Basin should focus on the remaining, relatively intact riverine habitat that currently supports a disproportionate share of wild salmon and steelhead. The City considered the anchor habitat reaches for fall Chinook when choosing habitat conservation measures (see Chapter 7).

All five anchor habitat reaches for fall Chinook are located in the lower Sandy River watershed, with three on the mainstem Sandy River and two on the lower ends of Trout and Gordon creeks. Fall Chinook spawning generally occurs from late October to early December, and it is concentrated in the lower Sandy River near Oxbow Park. Trout and Gordon creeks also support fall Chinook spawning and may serve as refuge areas for adult fish during high-flow events (ODFW 2001).

Abundance

Tule fall Chinook abundance and escapement are rarely documented in the Sandy River because this stock is believed to be an introduced run. It is unknown, however, whether the population is sustaining itself since hatchery plantings were curtailed in 1977. In October 1988, surveyors counted 828 redds and 920 fish, indicating tule escapement may be high in some years (ODFW 2002). In recent years, the mean abundance estimate of the fall Chinook tule stock was 183 adult fish in the Sandy River (NMFS 2003).

Various sources provide run estimates for the Sandy LRW fall Chinook stock. Though the numbers vary somewhat, depending on the years considered, most agree the stock is depressed. The average annual run estimate for returns to the Sandy River in 1984–1994 was 1,503 (ODFW 2002). Another estimate, for 1984–2001, was 504 individuals (NMFS 2003). Spawning escapement in 2000 reached a record low of only 88 individuals (ODFW 2003a). The winter subcomponent appears to be severely depressed based on declining spawner counts at index sites in Gordon and Trout creeks (ODFW 1997). In most years, only a handful of these fish have been observed or caught by anglers in the Sandy River.

More recently, Mobrand Biometrics (2004) summarized Sandy LRW fall Chinook stocks estimates for 1990–2000 from several sources. Three different estimates of LRW fall Chinook abundance for the Sandy River Basin are presented graphically in Figure 5-7 (Mobrand Biometrics, Inc. 2004). The information comes from ODFW's Fisheries Management and Evaluation Plan (2003a). The highest, lowest, and average run sizes between 1990 and 2000 are 2,060, 708, and 1,166 fish, respectively.

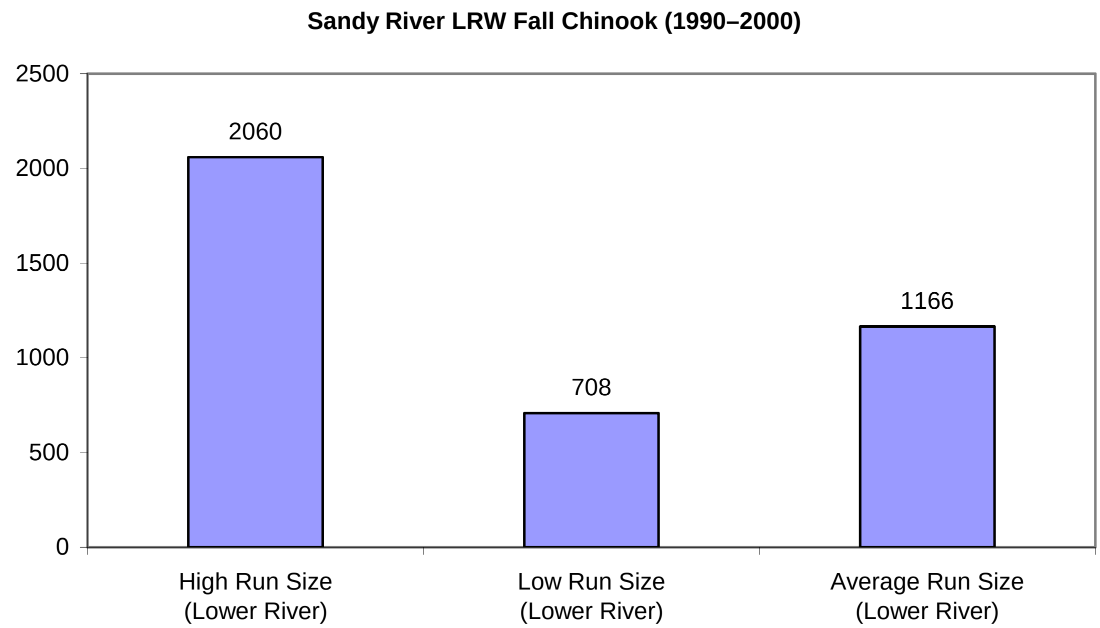

Figure 5-7. Estimates of Fall Chinook Abundance in the Lower Sandy River Below Marmot Dam

Source: ODFW 2003a

The ODFW Fisheries Management and Evaluation Plan (2003a) also established a critical abundance threshold[5] level of 300 natural-origin LRW spawners (to avoid short-term deleterious genetic and demographic effects). A viable abundance threshold[6] for Sandy LRW fall Chinook was set at 1,500 natural origin spawners (ODFW 2003a). The objective in the Oregon Administrative Rules (OAR 635-500-3470) is to maintain an annual average escapement of 1,500 wild late maturing fall Chinook to the standard survey spawning reach in the Sandy River Basin (river mile (RM) 6 to 13). A recovery goal has not yet been set by the WLC-TRT for the Sandy River Basin.

EDT modeling also provided an estimate of the current fall Chinook habitat conditions for producing 1,700 returns to lower Sandy River reaches 1 and 2. The estimate assumes an adult harvest rate of 33 percent, which approximates current conditions. Under fully restored freshwater habitat conditions, EDT estimates fall Chinook abundance would be approximately 3,000 adult spawners.

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[5] Critical abundance thresholds are those below which populations are at relatively high risk of extinction. Critical population size guidelines are reached if a population is low enough to be subject to risks from depensatory processes; genetic effects of inbreeding depression or fixation of deleterious mutations; demographic stochasticity; or uncertainty in status evaluations. If a population meets one critical threshold, it would be considered to be at a critically low level. Source: McElhany et al. 2000 (as cited in ODFW 2003a).

[6] Viability abundance thresholds are those above which populations have negligible risk of extinction due to local factors. Viable population size guidelines are reached when a population is large enough to survive normal environmental variation; allow compensatory processes to provide resilience to perturbation; maintain genetic diversity; provide important ecological functions; and not risk effects of uncertainty in status evaluations. A population must meet all viability population guidelines to be considered viable. Source: McElhany et al. 2000 (as cited in ODFW 2003a).

The EDT estimate for current conditions with harvest is higher than the average adult index count for the lower river (1,166).[7] However, the difference in the EDT adult abundance estimate compared to the index counts is expected because the EDT value is based on an additional 8.5 miles of spawning habitat. Because some fall Chinook spawning takes place outside the index area, ODFW considers the index count the minimum number of fall Chinook adults returning to the Basin each year.

The fall Chinook adult counts shown in Figure 5-7 indicate that the critical abundance threshold of 300 adults has consistently been met during the last decade and that the ODFW escapement target threshold of 1,500 adults has been met occasionally since 1990.[8]

Hatchery Production and Plantings

Current. Hatchery plantings of fall Chinook currently do not occur in the Sandy River. Hatchery straying has been confirmed through coded wire tag recoveries (ODFW 1997). Washougal Hatchery (located on the Washougal River, a tributary of the Columbia River, north of the mouth of the Sandy River) annually releases nearly six million fall Chinook fingerlings (ODFW 1997). Hatchery tule fall Chinook releases in years 1995–2001 totaled 32,878,694 in the Washougal River (NMFS 2003). It is possible the stray rate of hatchery tule fall Chinook in the Sandy River is moderated to some degree by low flows and relatively warm water in the lower Sandy River during August and September, and because the broad shallow conditions that exist at the confluence with the Columbia River during this period may deter entry of strays (ODFW 1997). Any influence on Sandy River fall Chinook is believed to be greatest on the early maturing tule stock, with little to no influence on the late-maturing stock (ODFW 1997).

Historical. Various hatchery plantings of primarily tule fall Chinook occurred intermittently in the Sandy River prior to 1977; since that time, no releases have been documented. Fall Chinook eggs were initially taken between 1903 and 1912 by the Oregon Fish Commission Hatchery located at the confluence of Boulder Creek and the Salmon River. Following construction of Marmot Dam in 1912, hatchery operations were moved to a station just downstream of the dam (ODFW 1997). Limited data from the 1913–1960 period indicate fall Chinook were also trapped at racks in the lower Sandy River, Bull Run River, Cedar Creek, and Gordon Creek for various releases in the Sandy River Basin and release sites in other basins (ODFW 1997). Sandy Hatchery produced Sandy stock fall Chinook between 1954 and 1976 for release into the Sandy River Basin and in support of other fall Chinook programs outside the Basin (ODFW 1997).

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[7] Fall Chinook numbers are based on index counts (1989–1995) and adult age composition data presented in Table 4 of the Chinook Fisheries Management and Evaluation Plan (ODFW 2003a).

[8] The low run size value is the minimum number of adults counted during the period of record. High run size is the largest number of adults counted during this same time period.

Photo courtesy of Bonneville Power Administration.

Harvest in the Basin

Current. Sport angling of fall Chinook in the Sandy River is limited to adipose-fin-clipped fish of hatchery origin. Since late maturing Sandy River stock fish are primarily wild, no harvest is allowed of LRW fall Chinook in the Sandy River Basin. ODFW estimates the current impact rate on LRW fall Chinook to be in the range of 2—4 percent, as incidental catch in the coho and winter steelhead fisheries (ODFW 2003a). The Sandy River is closed to angling of coho salmon on October 31 to protect spawning LRW fall Chinook. No angling is allowed for Chinook or coho salmon from November through January.

Ocean distribution of Sandy River LRW fall Chinook is unknown. Based on coded wire tag studies, however, LCR fall Chinook stocks generally migrate north (ODFW 1997). Harvest data on LRW fall Chinook generally come from Lewis River LRW fall Chinook, which are believed to be very similar in genetic makeup and run timing. Commercial ocean harvest proportions of Lewis River LRW fall Chinook (brood years 1985–1988) averaged about 9 percent in Oregon and 19 percent in Washington, whereas about 57 percent and 15 percent of the harvest occurred in British Columbia and Alaska, respectively (ODFW 1997). Commercial and sports fisheries outside the Basin, including ocean fisheries, may harvest up to 50 percent of the native fall Chinook run destined for the Sandy River based on harvest rates reported for Lewis River LRW stock fall Chinook (adult return years 1984–1993) (ODFW 1997). Harvest in the Sandy River has averaged 383 individuals annually for run years 1985–1994 based on salmon tag returns that are corrected for nonresponse bias. This estimate translates to an in-basin harvest rate of about 25 percent for the 10-year period

(ODFW 2002). Recent harvest rates from both ocean and freshwater fisheries for Sandy River LRW Chinook ranged from 25 to 51 percent (ODFW 2003a).

The EDT assessment for the Sandy River used an average harvest rate of 33 percent, citing ODFW's Fisheries Management and Evaluation Plan (2003a).

Historical. Sport angling harvest of fall Chinook in the Sandy River has always been limited. By the time adults enter the Sandy River, their body condition and flesh quality generally have deteriorated (ODFW 1997). Until recently, harvest was allowed on all fall Chinook stocks; however, effort was generally low because of fish condition. Though little historical harvest data exist, it is assumed that historical commercial and recreational ocean harvest levels were equal to or greater than the harvest rate currently exhibited today.

Reasons for Listing/Threats to Survival

Three principal sources of information are available to help explain why fall Chinook salmon have decreased in abundance in the Sandy River Basin: NMFS documents, ODFW reports, and EDT model results, as discussed below.

National Marine Fisheries Service. NMFS cites several factors for decline across the range of Chinook salmon. Water diversions for agriculture, flood control, domestic use, and hydropower purposes have greatly reduced, eliminated, and degraded suitable habitat. Additionally, forestry, agriculture, mining, and urbanization have degraded, simplified, and fragmented habitat.

Overexploitation of Chinook salmon has been considered a factor of decline even before extensive habitat degradation. Exploitation rates that have occurred after widespread aquatic and terrestrial habitat degradation have continued to be higher than most populations could sustain. Predation and disease have increased from introductions of nonnative species and artificially propagated salmonid fishes. Natural climatic conditions, including drought and poor ocean productivity, have further reduced natural production. Increased hatchery supplementation has led to increased competition and genetic introgression[9] between hatchery and naturally produced fish stocks.

In its decision to list the LCR ESU for Chinook, NMFS (1998a) indicated that major habitat problems are primarily related to blockages, forest practices, urbanization in the Portland and Vancouver areas, and agriculture in floodplains and low-gradient tributaries. They also stated that substantial Chinook salmon spawning habitat has been blocked (or passage substantially impaired) at several locations in the ESU. In the Sandy River Basin specifically, NMFS (1998a) listed Marmot Dam and the Bull Run dams as substantially impairing passage to historical spawning habitat.

Oregon Department of Fish and Wildlife. The Sandy River Subbasin Salmon and Steelhead Production Plan (ODFW 1990) and the Sandy Basin Management Plan (ODFW 1997 and

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[9] Genetic introgression is the movement of genes from one population or taxon into another via hybridization. ESA typically recognizes that small amounts of genetic introgression do not disqualify individuals or populations from "species membership'' or ESA protections, if those individuals or populations conform to the scientific taxonomic description of that species. A natural population of a particular species that possesses genes from another taxon at low frequency, yet retains the distinguishing morphological, behavioral, and ecological characters of the native species, may remain very valuable to the overall conservation and survival of that species.

2001) identify several factors that have reduced the production potential of native fall Chinook in the Sandy River Basin:

- Construction of Marmot Dam reduced the passage and natural production of fall Chinook upstream.
- Flow diversion at Marmot Dam reduced attraction water below the dam, and reduced spawning and rearing habitat in the 11-mile section down to the Bull Run River mouth.
- Much of the lower Sandy River below the Marmot Dam site is silted with sand and sediment eroded from the upper drainage when the snow melts in the late spring and summer. Siltation reduces the quality and quantity of fall Chinook spawning habitat.
- Construction of the Bull Run dams inundated historically accessible habitat and eliminated access above the dams.
- Snagging, poaching, and general harassment of fall Chinook spawners can be a problem on the redds in the lower Sandy River.
- Current sport and commercial fisheries may harvest up to 50 percent of the native Sandy River fall Chinook. The harvest on fall Chinook is a mixed-stock fishery, and the native late-run stock appears to be reduced to a remnant of past levels.
- LCR hatchery stock is known for its propensity to stray, and mixing of these fish with native Sandy River fall Chinook may detrimentally affect native stock. In addition, tule stock of fall Chinook in the Sandy River Basin may be mixing with and replacing the native stock.

EDT Modeling. Results from EDT modeling for the the Sandy River Basin estimate that the primary limiting factors for fall Chinook are the following:

- <u>Habitat diversity</u>. Habitat diversity has been lost throughout the Basin, although losses in the Bull Run and lower Sandy rivers are thought to have a large impact on fall Chinook.
- <u>Key habitat quantity</u>. Key habitat has decreased due to changes in habitat composition (pools, riffles, and glides) between current and historical conditions. The changes in habitat types are due to simplification of the stream channel, loss of large woody debris, increased confinement, and changes in low flow.
- <u>Channel stability</u>. The stream channel has become less stable in most of the Basin, due to a loss of large woody debris, impaired riparian function, and high streamflow.
- <u>Obstructions</u>. The two Bull Run dams have blocked fall Chinook passage.

Other minor limiting factors include changes in flow (primarily low flow in the Bull Run River), maximum stream temperature (from low flow), fine sediment (loss of riparian habitat and landslides), and food (decreased salmon carcass abundance). Figure 5-8 shows the limiting factors for fall Chinook in the Sandy River Basin by watershed.

	Limiting Factors															
Geographic Area	Channel Stability	Chemicals	Competition (hatch)	Competition (other species)	Flow	Food	Habitat diversity	Hasassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Bull Run River	●				●	●	⬤		⬤				●	●		●
Columbia River			•				•					•				⬤
Lower Sandy River	•				•	•	●	•				•	●			•
Middle Sandy River					•	•	•						•			•
Upper Sandy River	•				•	•	●						●			•
Salmon River	•				•	•	●									●
Zigzag River	•				•		●						•			•

Figure 5-8. Limiting Factors for Fall Chinook in the Sandy River Basin[a,b]

Percentage change from historical conditions	Worse
Less than 1%	
Between 1 and 5%	•
Between 5 and 20%	●
More than 20%	⬤

Source: EDT model run 10/20/2005.

[a]Appendix D provides definitions of the limiting factors (level 3 survival factors) and the habitat attributes (level 2 environmental attributes) and a matrix showing the relationship between them.

[b]The habitat attributes are also used in Chapter 8 and Appendix E to define the reference condition for the habitat benefits that arise from the City’s HCP measures.

At least 50 percent of the loss in fall Chinook production for all reaches combined is due to degraded conditions throughout the Basin as a result of the following five habitat attributes:

- Increase in stream temperature
- Decrease in low streamflow
- Loss of riparian function
- Loss of large woody debris
- Increase in fish pathogens

These habitat attributes are shown as the reference condition in the effects chapter (Chapter 8). The relationship between the limiting factors and the habitat variables, as well as detailed definitions of the factors and attributes, are presented in Appendix D.

Fall Chinook in the Bull Run Watershed

Distribution

Anadromous fish historically used about 49 stream miles in the Bull Run River watershed, which includes 10 miles of stream for the Little Sandy River (see Table 4-8). Of the 39 stream miles in the Bull Run River (excluding the Little Sandy River), fall Chinook had access to approximately 10.5 miles upstream of Bull Run Dam 2. Of that area historically available to fall Chinook, all but approximately 1.5 miles are now inundated by Bull Run reservoirs. Figure 5-9 shows the estimated periods of occurrence for fall Chinook life stages in the lower Bull Run River.

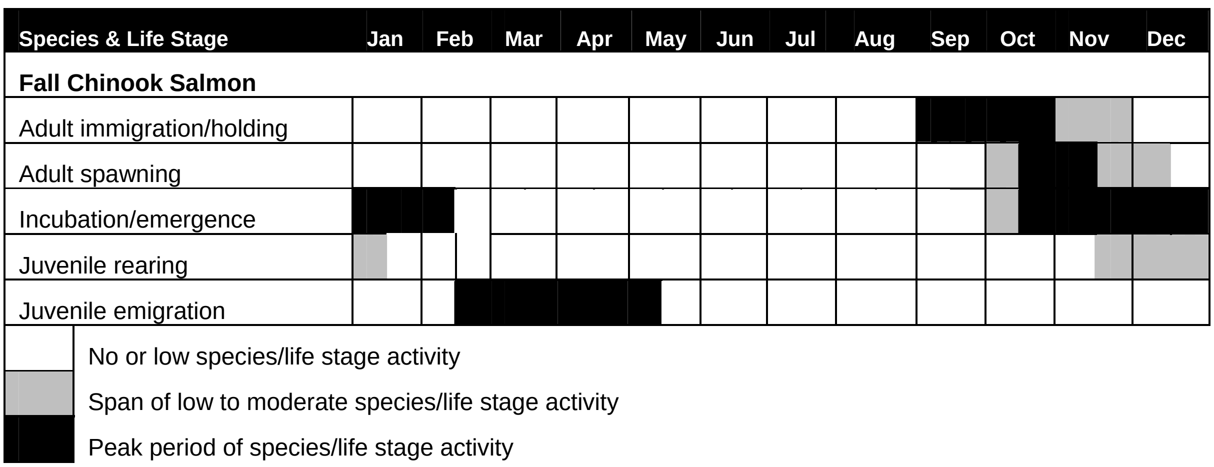


Figure 5-9. Estimated Periods of Occurrence for Fall Chinook in the Lower Bull Run River

Source: Sandy River Basin Agreement Technical Team 2002.

Table 5-1 shows the river segments and historical distribution of fall Chinook in the Bull Run River. Figure 5-6 on page 5-12 shows historical fall Chinook distribution throughout the Sandy River Basin.

Table 5-1. Historical Distribution of Fall Chinook in the Bull Run River

River Segment	River Miles
Lower Bull Run River	
Bull Run River (mouth to Dam 2 spillway weir)	5.8
Little Sandy River (mouth to Little Sandy Dam site)	1.7
Little Sandy River (Little Sandy Dam site to middle waterfalls)	5.6
Upper Bull Run River	
Bull Run River (Dam 2 spillway weir up through reservoirs)	9.2
Bull Run River (free-flowing river to waterfall at RM 16.3)	1.3

Source: USFS, 1999

Fall Chinook currently can use about 7.5 stream miles of habitat in the Bull Run River watershed. Of this total, approximately 5.8 miles occur in the lower Bull Run River downstream of the Headworks, with an additional 1.7 miles in the Little Sandy River.

Abundance

EDT modeling also provided an estimate of abundance based on the current fall Chinook habitat conditions for fall Chinook. The estimated production in the lower Bull Run and Little Sandy rivers was 178 and 1,598 adults, respectively.[10] Juvenile production was estimated at approximately 11,000 for the current condition and about 50,000 for the historical condition.

EDT estimates are similar to recent empirical data for Chinook salmon abundance in the lower Bull Run River. The City completed adult Chinook surveys in the late 1990s and in 2005 (Clearwater BioStudies 2006) for an index reach of the Bull Run River (RM 1.5—RM 3.9), while the EDT estimates are for all of the lower Bull Run and Little Sandy rivers. The total number of Chinook salmon redds was 27, 34, and 68 for the 1998, 1999, and 2005 surveys, respectively. In those years, the peak number of live and dead Chinook salmon ranged from 49 to 165 adult fish. However, it was not possible to differentiate between the spring and fall Chinook salmon redds. New Chinook redds have been observed in the lower Bull Run River through late November, a pattern that could reflect late spawning by a few spring Chinook salmon, but it is also consistent with the spawn timing of the Sandy River's late-run fall Chinook (Clearwater BioStudies 2006).

Habitat Conditions

The Portland Water Bureau, U.S. Forest Service (USFS), and other agencies have been studying the aquatic habitat of the lower Bull Run River since the mid-1990s. From about

[10] Historical fish numbers as defined in EDT assume pristine habitat conditions in the Bull Run, Sandy, and Little Sandy rivers, but current habitat conditions in the Columbia River and estuary. The numbers therefore do not reflect the true historical production potential of the species.

1997, the City has conducted a number of studies aimed at determining current conditions and factors affecting abundance and production of fall Chinook in the Bull Run River watershed. In particular, the City's studies have focused on current habitat conditions and use by anadromous species, primarily Chinook salmon and steelhead, in the lower 5.8 miles of the Bull Run River (Clearwater BioStudies 1997; R2 Resource Consultants 1998a,b; Beak 1999, 2000a,b,c). The studies indicate that the following key environmental factors may have affected abundance and productivity of fall Chinook salmon:

- Low flows may reduce the amount of instream habitat suitable for use by spawning fall Chinook.
- Gravel in the lower river suitable for spawning and construction of redds is lacking or absent.
- Trapping of large woody debris in the upper reservoirs does not allow the wood to pass through the lower Bull Run River, and beneficial habitat may be lost as a result.
- Dams block access to potential upstream spawning habitat.
- Rapid, short-term flow fluctuations may strand or displace Chinook fry.

Management of the Bull Run River water supply has affected the flow patterns of the lower Bull Run River. The City stores water behind its dams and diverts a portion of the Bull Run River watershed yield for municipal and industrial uses. The greatest impact on fall Chinook caused by low streamflows in the lower Bull Run River is from mid-October to the end of December, which is the primary spawning time for Lower River Wild fall Chinook. The impact of water diversions on the lower Bull Run River is substantially smaller during the winter and spring when incubation and fry emergence for fall Chinook occurs. The reservoirs are usually full during this period, and municipal demand is much lower than in the summer.

An analysis of gravel availability and spawning use in the lower Bull Run River by Beak Consultants (2000a) indicates that lack of suitable spawning gravel may be limiting production of Chinook salmon. Beak Consultants (2000a) counted Chinook spawning redds in the lower river and estimated the total quantity and distribution of gravel suitable for Chinook spawning in the lower river. The similarity in estimated number of suitable redd patches and actual redd counts suggest that available suitable gravel area in the lower river downstream of Larson's Bridge is probably fully utilized. On this basis, it was concluded that suitable gravel is in very low supply in the lower river and is likely limiting Chinook salmon production.

Limiting Factors

Reach-specific results for fall Chinook salmon in the Bull Run River watershed are summarized in Figure 5-10. This summary indicates that the most affected life stages among the reaches in the watershed are emerging fry (fry colonization), incubating eggs (egg incubation), migrating adults (prespawning migrant), and holding adults (prespawning holding), followed by spawning adults (spawning) and subyearling rearing (0-age active rearing).

Ten limiting factors affect fall Chinook survival in the watershed. Of these, habitat diversity, key habitat quantity, flow, and food have a high effect in depressing productivity in several reaches. In addition, channel stability has a high effect in lower Bull Run River reaches (Bull Run 1 through Bull Run 4), and obstructions have a high effect on reaches of the Bull Run River above RM 5.8. This is, of course, because Bull Run Dam 2 blocks all anadromous fish access into the upper Bull Run watershed at RM 5.8. Water temperature also has a moderate effect in lower Bull Run River reaches (Bull Run 1 through Bull Run 4).

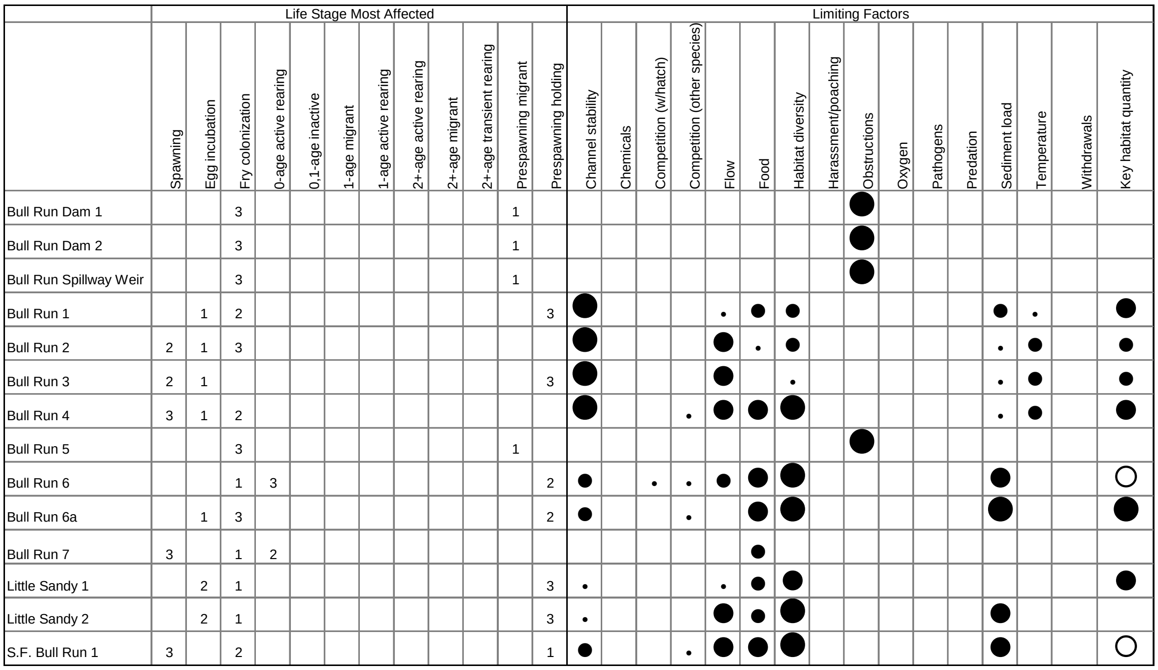
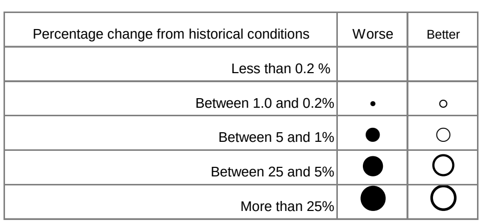


Figure 5-10. Limiting Factors for Fall Chinook in the Bull Run River Watershed[a,b]



Source: EDT model run 10/20/2005.

[a]Appendix D provides definitions of the limiting factors (level 3 survival factors) and the habitat attributes (level 2 environmental attributes) and a matrix showing the relationship between them.

[a]Bull Run reaches 5 and higher are the reaches at or above the Dam 2 diversion pool and include the reservoirs. The limiting factors in this figure for Bull Run reaches 5 and above are primarily the results of inundation of the Bull Run River by the reservoirs.

Flow and Fall Chinook Habitat Preferences

Because City operations in the Bull Run divert flow from the watershed and that effect is a focus of this HCP, additional information on the relationship between streamflow and fish habitat preferences is provided below for Chinook salmon.

Spawning Flow-Habitat Relationships. Figure 5-11 shows the relationship between total usable habitat and flow for spawning Chinook salmon in the lower Bull Run River between Dam 2 (approximately RM 5.8) and PGE's powerhouse at RM 1.5. These relationships were developed for Chinook salmon and are applicable for both the fall and spring runs of Chinook.

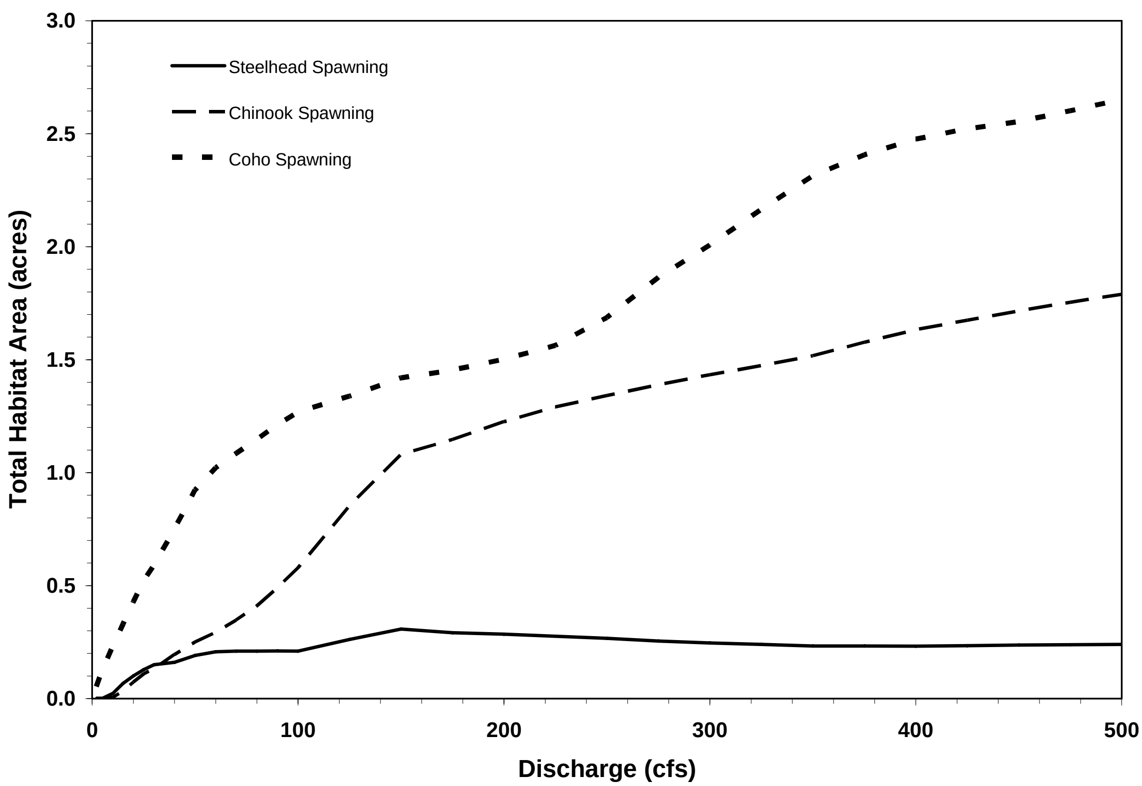


Figure 5-11. Relationship Between Flows in the Lower Bull Run River and Available Spawning Habitat for Chinook, Coho Salmon, and Steelhead

Source: R2 Resource Consultants 1998a.

Within the flow range modeled (0–500 cfs), the relationship for Chinook indicates that spawning habitat increases with increasing discharge.

Juvenile Rearing Flow-Habitat Relationships. Figure 5-12 shows the relationship between total usable habitat and flow for rearing juvenile Chinook in the lower Bull Run River.

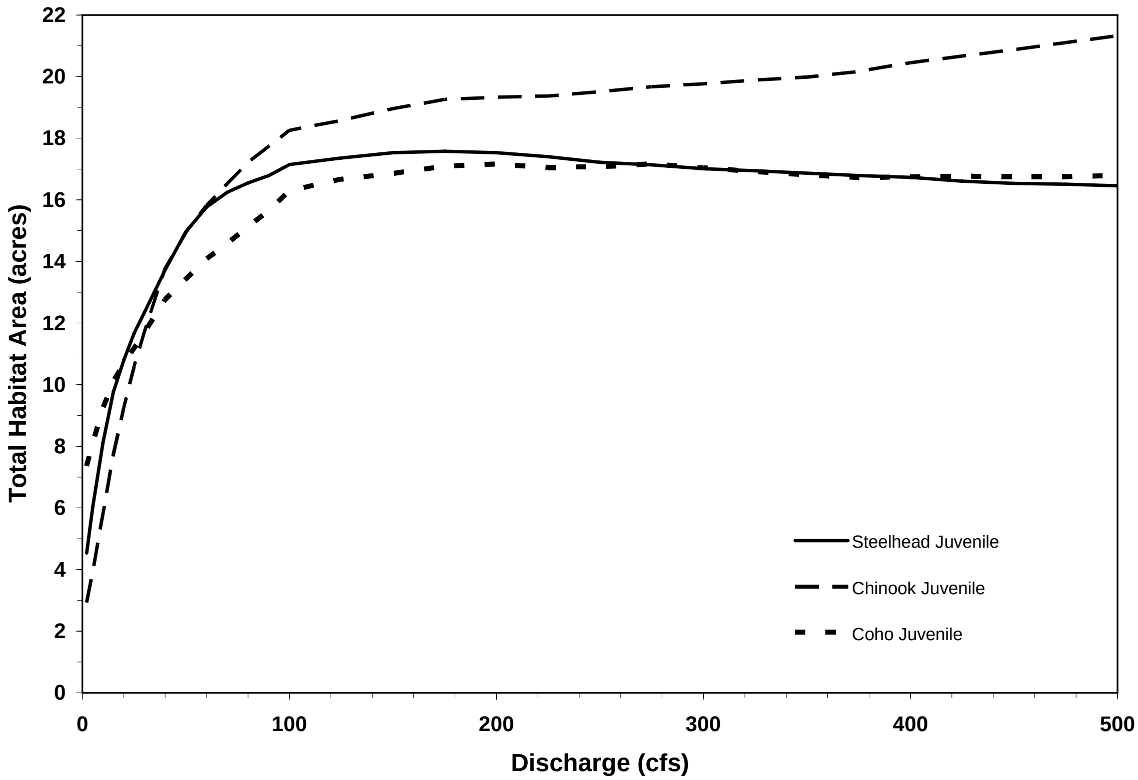


Figure 5-12. Relationship between Total Usable Habitat and Flow for Rearing Juvenile Chinook in the Lower Bull Run River

Source: R2 Resource Consultants 1998a.

Results of PHABSIM modeling indicate that habitat conditions for juvenile Chinook salmon increase at a rapid rate between 0 and 100 cfs, with most of the rapid increase occurring between 0 and 20 cfs (R2 Resource Consultants 1998a). Habitat conditions for juvenile Chinook and other salmonids become near constant at flows above 100 cfs.

The results of the PHABSIM modeling are expressed as weighted usable area (WUA), an index of available instream habitat at various increments of flow. R2 Resources Consultants estimated WUA for a number of flows in various reaches of the lower Bull Run River by (1998a) using the PHABSIM model. The WUA estimates for each species are shown in Chapter 8, Effects of the HCP.

Spring Chinook in the Sandy River Basin

Life History and Diversity

Natural origin spring Chinook salmon (*O. tshawytscha)* belong to the LCR ESU and are currently listed as threatened under the federal ESA. Available information suggests that spring Chinook salmon currently present in the Clackamas and Sandy rivers are predominantly the result of introductions from the Willamette River ESU, and thus are probably not representative of spring Chinook salmon found historically (NMFS 1998a). Genetic analysis suggests that naturally reproducing spring Chinook salmon in the upper Sandy River have retained at least a low level of genetic differentiation from upper Willamette River stock spring Chinook salmon propagated in the Clackamas Hatchery (Bentzen 1998). The current spring Chinook salmon stock using the Bull Run River could have been derived from either the Sandy "native" population or the Clackamas "hatchery" population. The NMFS WLC-TRT classifies the Sandy River spring Chinook stock as a population of "genetic integrity," meaning it resembles the historical life histories and genetic types in the Sandy River Basin (McElhany et al. 2003).

Adult spring Chinook salmon enter the mouth of the Columbia River as early as late January and early February in preparation for their spawning run, which can take six months or longer and cover a distance of several hundred miles. Columbia River spring Chinook salmon bound for the Sandy River begin entering the Sandy River delta as early as February, but more commonly in April and May. Peak migration over Marmot Dam into the upper Sandy River Basin has usually occurred in June, with a smaller peak occurring in September. Migration into the upper Basin subsides in July and August, probably due to a seasonal increase in water temperature and decrease in instream flow (ODFW 1997). Figure 5-13 shows estimated periods of occurrence of spring Chinook life stages in the upper portions of the Sandy River Basin.

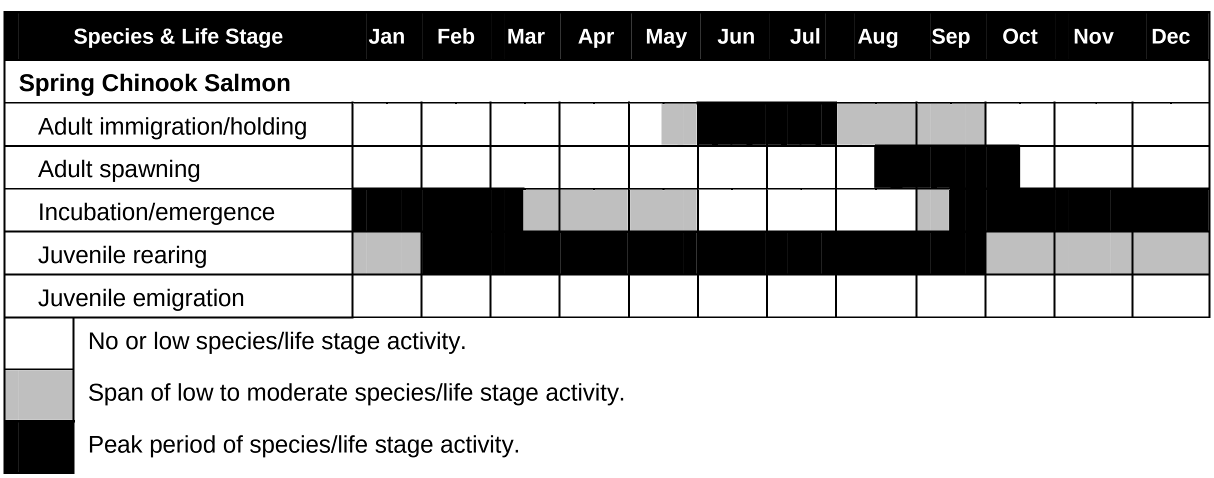


Figure 5-13. Estimated Periods of Occurrence for Spring Chinook in the Upper Sandy River Basin Above the Marmot Dam Site

ODFW currently lists spring Chinook returning to the Sandy River Basin in the Willamette Spring Chinook Gene Conservation Group, which includes populations returning to the

McKenzie, Santiam, Molalla, and Clackamas rivers. All of these rivers are major tributaries to the Willamette River (ODFW 1997). Life-history data from the Sandy River are limited, and transplantation records indicate the Sandy River Basin has received overwhelmingly large numbers of upper Willamette River spring-run Chinook salmon (Myers et al. 1998).

Photo courtesy of Bonneville Power Administration.

Spawning occurs primarily in August through October, peaking in September. Fry emergence typically occurs in middle to late winter, followed by a downstream migration to large mainstem areas for rearing. Juvenile spring Chinook rearing distribution is not well documented in the Sandy River Basin (ODFW 1997). Natural origin Sandy River juvenile spring Chinook primarily exhibit two outmigration strategies. The majority of smolts migrate to the ocean in the spring of their second year (at age 1+ as stream-type fish); however, a significant portion may outmigrate in the fall as subyearlings. The percent of subyearling smolts in the population depends upon the annual variability of habitat conditions that might facilitate rapid growth. Once Willamette stock spring Chinook enter the ocean, they typically migrate north to British Columbia and Alaska (ODFW 1997). Willamette River spring Chinook typically mature in their fourth and fifth year of life, with the majority maturing at age four (ODFW 2001).

The NMFS WLC-TRT classified the spring run as both a “core” and a “genetic integrity” population in their recovery planning efforts. These designations mean that the population historically was abundant and productive; the current population resembles the historical life histories and genetic types in the Sandy River Basin; and the population presently offers one of the most likely paths to recovery in the Lower Columbia Chinook ESU (McElhany et al. 2003). The LCRFRB designated the priority for contribution of this stock to recovery goals in the ESU as “primary.” This classification means the Sandy River spring Chinook stock is targeted for recovery as one of four stocks in the Cascade “stratum” to achieve viable population levels with greater than 95 percent probability of persistence (i.e., negligible extinction risk within 100 years) (LCRFRB 2004; McElhany et al. 2003; McElhany et al. 2004).

Distribution

The SRBTT developed a completed list of the reaches in which each natural population of anadromous salmonids was known or assumed to spawn, either currently or historically (Mobrand Biometrics 2004). For streams in which data were not available to determine species use, the SRBTT assumed that Chinook (spring and fall) would not utilize streams with a minimum width less than 15 feet or a gradient higher than 8 percent. After initial EDT model runs were completed in 2001, the SRBTT met again to review the results and re-examine spawning distribution in the Sandy River Basin. Based on this review, several spawning reaches were excluded for some species and added for others. This distribution information was used to develop Figures 5-14 and 5-15.

Current. Current spring Chinook distribution in the Sandy River Basin is shown in Figure 5-14. Spring Chinook in the Basin have utilized the mainstem Sandy River from the mouth upstream to Marmot Dam for migration and rearing (SRBP 2005). Recent data also show spring Chinook use in the lower Sandy River (Tonnes, pers. comm., 2005). Sandy River spring Chinook salmon have spawned primarily upstream of Marmot Dam, with most spawning occurring in the Salmon River up to Final Falls (near RM 14) and in Still Creek from its confluence upstream about 3 miles (ODFW 1997). Spawning also occurs in the Zigzag River, in the upper Sandy River (mostly above Clear Creek), and in the lower reaches of Clear Creek and Lost Creek (ODFW 1997). Spawning has also been documented in the lower Bull Run and Little Sandy rivers (R2 Resource Consultants 1998a). Spawning probably occurs in the mainstem Sandy River side channels and tributaries when sufficient flows exist. Additionally, the Sandy River and associated tributaries above the Marmot Dam site support migration and rearing of juvenile and adult life forms.

Historical. Historical spring Chinook distribution assumed in the Sandy River Basin is shown in Figure 5-15. Upstream of the Marmot Dam site on the mainstem Sandy River, most of the habitat historically utilized by spring Chinook is largely intact, except for the habitat affected by the channelization efforts in the Salmon and Zigzag rivers following the 1964 flood (ODFW 1997). Approximately 24 miles of streams in the Bull Run River watershed (above the dams) were historically available to Chinook (City of Portland 2002), plus six miles of the lower watershed that are currently accessible. Spring Chinook were also likely endemic to the Little Sandy River.

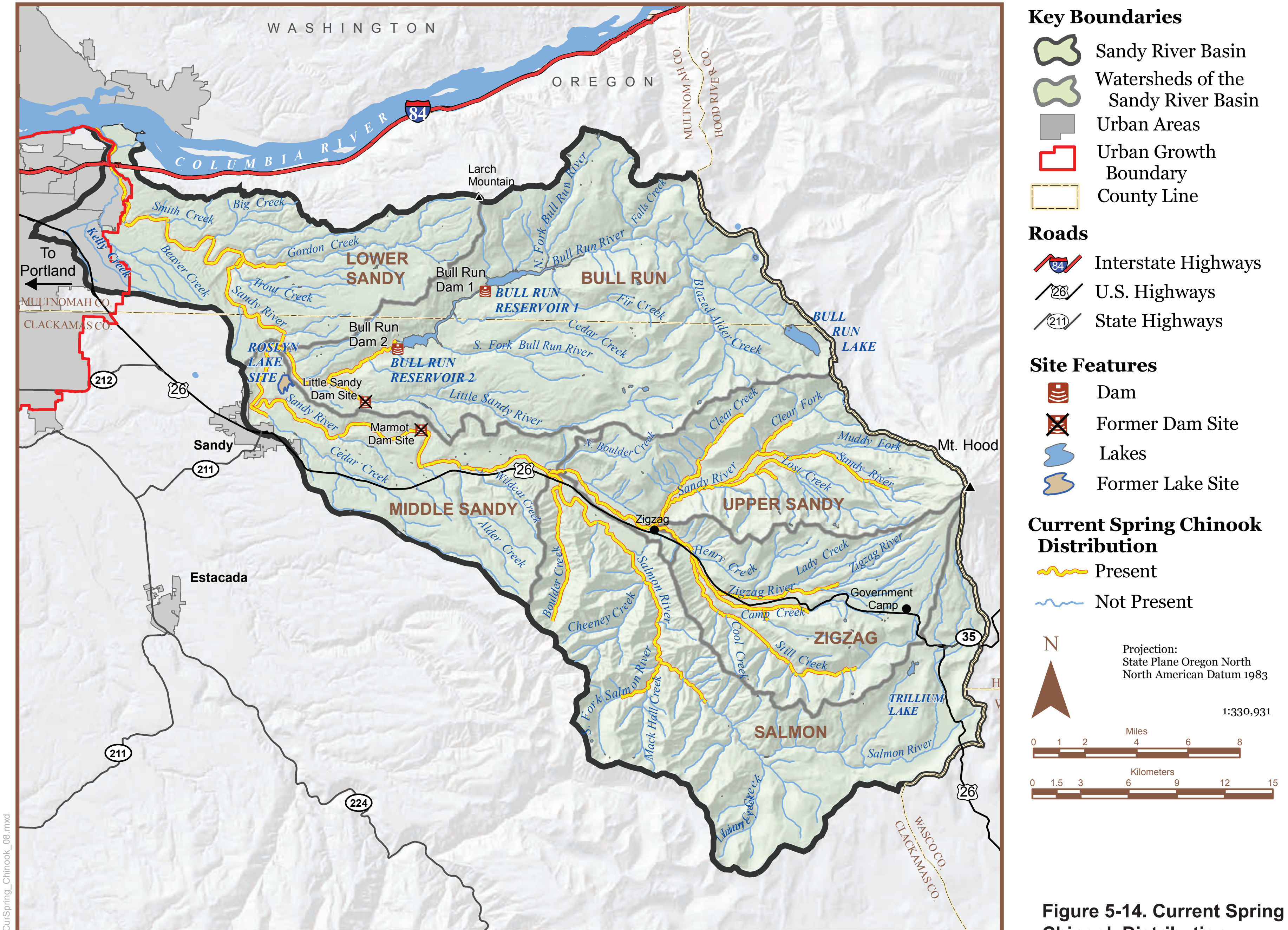


Figure 5-14. Current Spring Chinook Distribution

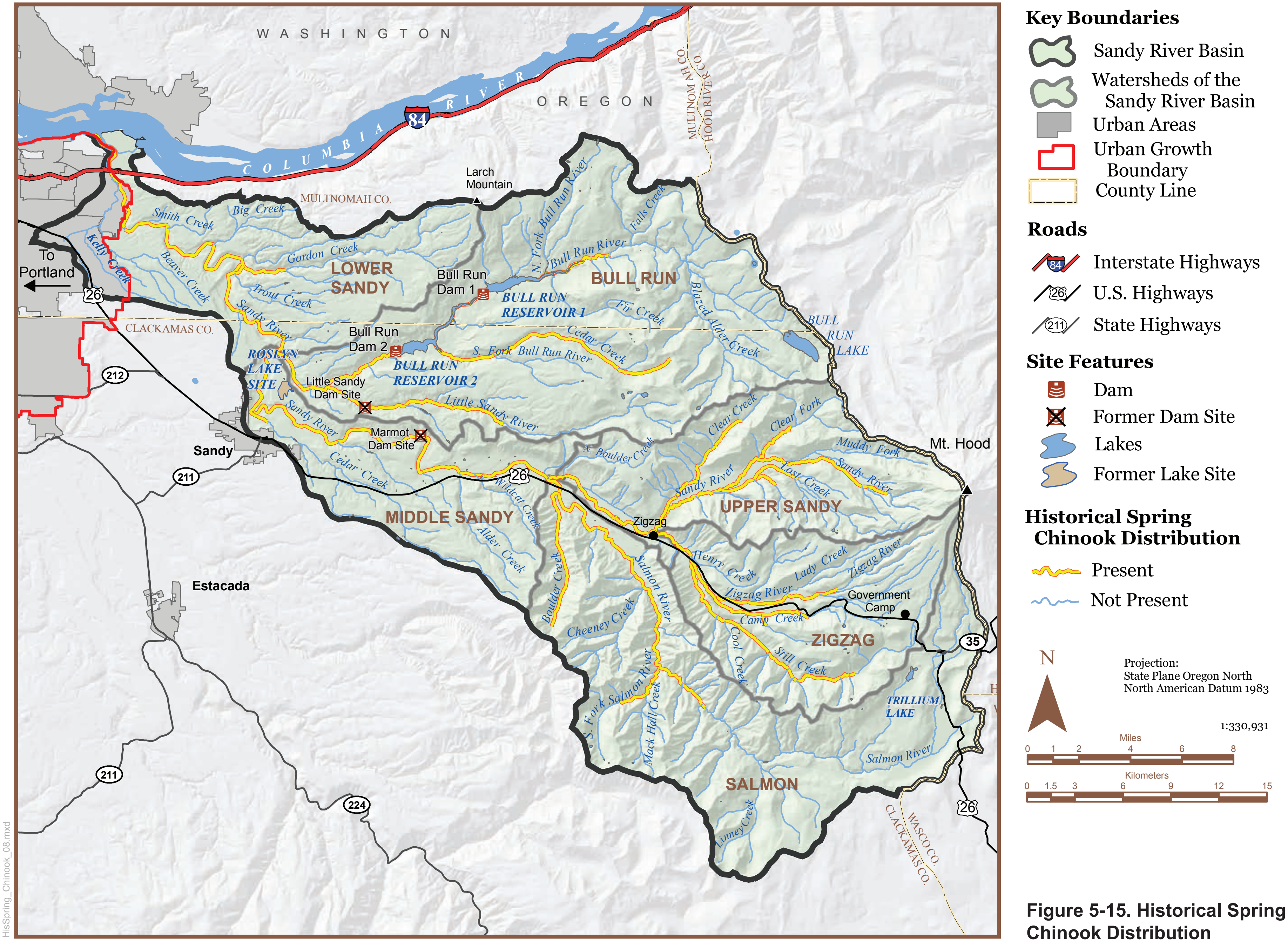


Figure 5-15. Historical Spring Chinook Distribution

Anchor Habitat. The City considered the anchor habitat reaches for spring Chinook when choosing off-site areas (non-Bull Run) that should be emphasized for HCP conservation measures (see Chapter 7). Spring Chinook anchor habitat is generally located in the upper Sandy River Basin upstream of Cedar Creek. The anchor habitat analysis, which is based on current conditions, identified several anchor habitat reaches for spring Chinook (SRBWG 2006). Two reaches in the mainstem Sandy River from approximately RM 24 (two miles upstream from the confluence with Cedar Creek) to the Salmon River confluence were identified as anchor habitat. These reaches are in the middle Sandy River watershed. All of the mainstem Salmon River up to Final Falls (RM 14), the Sandy River from the Salmon River confluence to the Zigzag River, the lower end of Clear Fork in the upper Sandy River watershed, and the lower end (downstream of Cool Creek) of Still Creek were also identified as anchor habitats for spring Chinook.

Abundance

The abundance of Sandy River spring Chinook salmon has increased dramatically since the 1970s, probably due to increased hatchery smolt releases and the establishment of minimum flow requirements in the mainstem Sandy River below Marmot Dam. Although little historical data exist, minimum run estimates during the 1950s and 1960s varied from a low of 51 adults in 1965 to a high of 689 adults in 1964 (ODFW 1997). Minimum run estimates were based on Marmot Dam fish counts and ODFW sport catch counts derived from angler punch cards. Marmot Dam fish counts were not conducted from 1971 through 1977, but were reestablished in 1978. Minimum run estimates from 1978 through 1995 varied from a low of 735 adults in 1978 to a high of 8,551 in 1992 (ODFW 1997).

Most spring Chinook returning to the Sandy River Basin are believed to be of hatchery origin, though natural production continues to occur primarily above the Marmot Dam site (ODFW 2002). Sandy stock spring Chinook were primarily used for hatchery supplementation from the early 1900s through 1969. Beginning in the 1970s, a program was initiated to supplement the depleted native run with Willamette stock spring Chinook (ODFW 2002). It is likely that genetic introgression between native Sandy spring Chinook and Willamette stock spring Chinook occurred; however, the upper Sandy River retains at least a low level of genetic differentiation from upper Willamette River stock (Bentzen 1998).

Between 1997 and 2007 when Marmot Dam was decommissioned, fin-clipped hatchery and wild spring Chinook were separated at the Marmot Dam fish ladder to obtain information on hatchery and wild fish in spawning populations. Beginning with the 1997 brood, the intent was to mark all hatchery Chinook. However, until 2002, about three percent of hatchery fry and pre-smolts have been released in the Basin without fin clips. Given the large numbers of hatchery fish released, even this small percentage of unmarked hatchery fish biased the estimates of wild spawners until 2002, especially because the number of wild fish in the Basin was low.

Sandy stock spring Chinook were primarily used for hatchery supplementation from the early 1900s through 1969. Beginning in the 1970s, a program was initiated to supplement the depleted native run with Willamette stock spring Chinook (ODFW 2002) and most spring Chinook returning to the Sandy River Basin are believed to be of hatchery origin. A genetic analysis (Bentzen 1998) determined that naturally spawning spring Chinook were intermediate to Clackamas River (i.e., Willamette stock) spring Chinook and LCR spring Chinook stocks. The analysis also determined there was little genetic resemblance to the fall Chinook of the Sandy River, which is counter to trends in other lower Columbia River watersheds. Therefore, the naturally spawning spring Chinook stock retains some original genetic characteristics (WLC-TRT 2003).

Three different estimates of adult spring Chinook abundance are graphically displayed in Figure 5-16. The data were taken from ODFW's Fisheries Management and Evaluation Plan (ODFW 2003a). The fish were sampled from the fish trap/ladder at Marmot Dam so they do not include adult fish that would have spawned below the dam in the lower Sandy River Basin. The highest, lowest, and average run sizes between 1990 and 2000 were 4,451, 1,503, and 2,810 fish, respectively. These counts include hatchery and wild fish.

The ODFW Fisheries Management and Evaluation Plan (2003a) states that a viable abundance threshold of Sandy River spring Chinook is 2,000 natural origin spawners, which is identical to the ODFW spring Chinook escapement goal of 2,000 adults for the Sandy River Basin (ODFW 2001). The objective in the Oregon Administrative Rules (OAR 635-500-3460) is to achieve an average annual spawning escapement of 2,000 wild spring Chinook into the Sandy River Basin. Beginning in 2002, all hatchery-reared spring Chinook returning to the Sandy River Basin have been distinguished from wild fish by an adipose fin clip. In run years 2002–2003, an average of 1,229 natural origin spawners passed the Marmot Dam fish ladder. The critical abundance threshold (set to avoid short-term deleterious genetic and demographic effects) was set at 300 natural origin spawners (ODFW 2003a).

EDT estimates of adult spring Chinook production were also determined based on the same geographic point of reference used for the empirical abundance estimates in ODFW (2003a) and on the same harvest rate. EDT estimates of adult abundance include all spawning areas upstream of Marmot Dam. The estimates do not include production occurring from mainstem Sandy River reaches downstream of Marmot Dam or lower river tributaries, including the Bull Run River.

EDT estimates that the current habitat conditions for stream reaches above Marmot Dam could produce approximately 1,400 spring Chinook adults annually. The number of adults returning each year assumes an ocean and freshwater fisheries harvest of 39 percent of all adults (Mobrand Biometrics 2004). The EDT estimate based on current conditions is lower than the average number of adults counted at Marmot Dam from 1990–2000 (2,229).

The Marmot Dam counts indicate adult returns to the Basin exceed both the critical and viable threshold levels defined by ODFW.

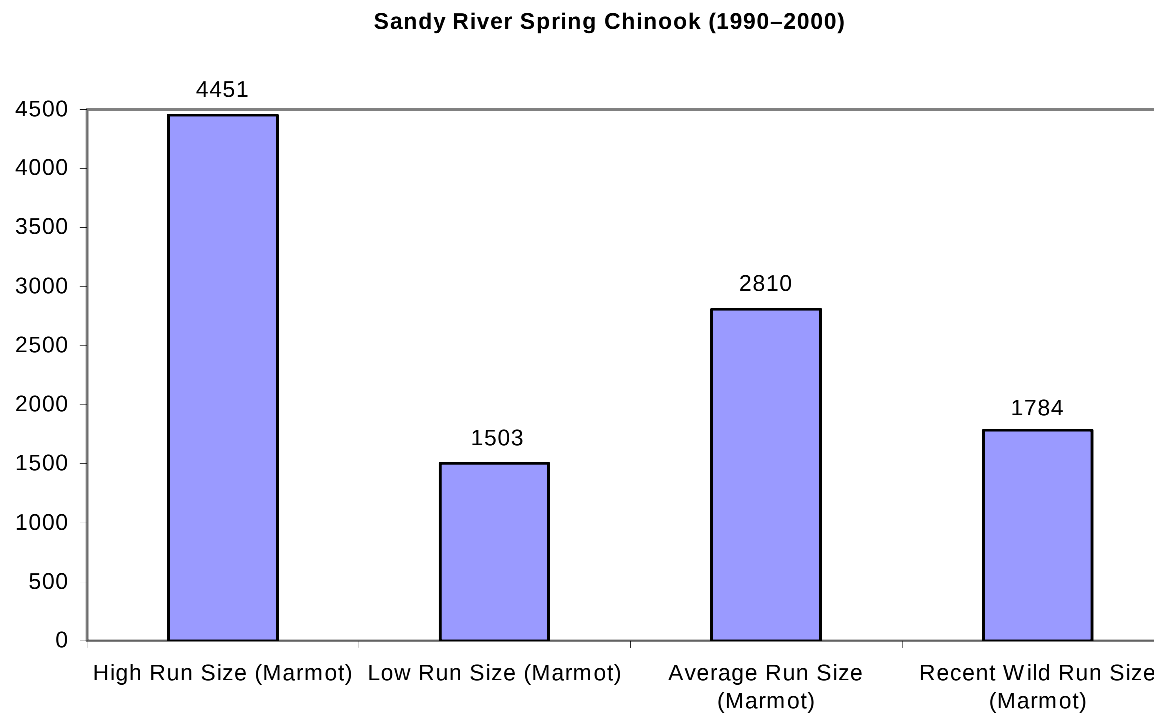


Figure 5-16. Estimates of Spring Chinook Abundance Upstream of Marmot Dam

Source: ODFW 2003a.

Hatchery Production and Plantings

Current. Beginning in 2002, adult spring Chinook brood stock collection occurred exclusively at the Marmot Dam fish trap with the intent of collecting natural-origin Sandy River spring Chinook for hatchery supplementation. Brood stock were collected and transferred to the Clackamas Hatchery for egg-take, incubation, and rearing (Bourne, pers. comm., 2004). Pre-smolts were transferred to the Sandy Hatchery on Cedar Creek for acclimation prior to release (Bourne 2004). In 2006, 300,000 Sandy stock spring Chinook smolts were released annually from Sandy Hatchery (ODFW 2006). The City funds the production of about 160,000 spring Chinook smolts under Federal Energy Regulatory Agency (FERC) license 2821. PGE funds the production of 100,000 spring Chinook smolts under FERC license 477.

Historical. Sandy River stock spring Chinook were primarily used for hatchery supplementation from the early 1900s through 1969. Spring Chinook smolt releases began to increase substantially in the 1970s with the introduction of Willamette stock spring Chinook reared at Clackamas Hatchery. Willamette stock spring Chinook were released in the Sandy River Basin exclusively through 2001, except in 1977 and 1978 when Carson Hatchery stock (Washington) was released (ODFW 1997). Hatchery releases averaged about 200,000 smolts for release years 1977–1985 and increased to an annual average of 420,985 for release years

1986–1996 (ODFW 1997). Increased smolt releases in the mid-1980s were primarily a result of mitigation to compensate for lost natural production in the Bull Run watershed.

Harvest in the Basin

Current. The Sandy River recreational spring Chinook fishery is important economically to local communities. Sandy River spring Chinook support a substantial sport fishery in the lower river (Taylor 1998), and the fish from this hatchery are highly desirable because their flesh is in peak condition and they are fairly large fish. Beginning in 2002, harvest of spring Chinook salmon in the Sandy River Basin was limited to adipose-fin-clipped fish of hatchery origin. All wild fish are required to be released. By implementing a selective fishery for hatchery spring Chinook in the Sandy River Basin, harvest rates are estimated to be reduced by more than 85 percent from historical levels (NMFS 2003). Before selective fishing regulations were implemented in 2002, harvest rates on naturally produced spring Chinook in the Sandy River were approximately 40 percent (NMFS 2003). Since 2002, cumulative fishery harvest impacts on wild spring Chinook salmon have not been expected to exceed 18.3 percent in ocean, mainstem Columbia River, and Sandy River fisheries (ODFW 2003a). In-basin sport fishing impacts are projected to be in the range of 4.2 to 6.1 percent per year (ODFW 2003a).

Historical. Recreational spring Chinook harvest dates back to 1956, based on estimates derived from ODFW punch card returns. Low harvest levels from 1956 through 1978 paralleled trends in low returns to the Basin. Average sport catch in the Basin was approximately 120 fish per year during the period 1956–1978. During run years 1979–1994 average sport catch harvest in the Basin increased to an average of 1,193 fish per year. Harvest goals in the Basin were set in 1990 by the Sandy Fish Management Plan (ODFW 1997). The total run goal of 4,500 spring Chinook allocated an in-basin harvest of 2,000 and a spawner escapement of 2,500 adults (ODFW 1990). The 1990–1994, on average, the in-basin harvest goals and spawning escapement goals were met for the Sandy River (ODFW 1997). The 1990 management goals did not differentiate between native and hatchery adults in the runs. Cumulative fishery impacts on natural origin Sandy River spring Chinook in ocean, mainstem Columbia River, and Sandy River fisheries ranged from 50 percent in 1984–1993, to 39 percent in 1994–1998, and to 40 percent in 1999 (SRBP 2005).

Reasons for Listing/Threats to Survival

The factors of decline and reasons for listing of spring Chinook are similar to those previously described for fall Chinook. Descriptions are available from ODFW and EDT results, as presented below.

Oregon Department of Fish and Wildlife. The Sandy River Subbasin Salmon and Steelhead Production Plan (ODFW 1990) and the Sandy Basin Management Plan (ODFW 1997 and 2001) identify several factors that have reduced the production potential of native spring Chinook in the Sandy River Basin:

- In the mainstem Sandy River, spring Chinook spawn above Cedar Creek. Above the Salmon River, sedimentation from snowmelt silt, a lack of gravel, channelization, and the low pool-to-riffle ratio limit spring Chinook production in most reaches.

- In the upper tributaries, a lack of pools, a lack of gravel, and sedimentation limit the production of spring Chinook smolts.
- Before minimum flows were maintained below Marmot Dam, low flow conditions from the dam to the Bull Run River confluence hindered the upstream passage of salmon and steelhead and probably contributed to the decline of spring Chinook salmon.
- Prior to the screening in 1951, PGE's unscreened diversions of water to Roslyn Lake and the turbines of the Bull Run powerhouse are believed to have contributed to a decline of smolts produced in the upper Basin.
- Originally, hatchery smolts were released in the middle and upper reaches of the Sandy River, and competed with naturally produced spring Chinook in the upper Basin. From 1994-2007 when Marmot Dam was decommissioned, all hatchery smolts were released downstream of Marmot Dam.
- Spring Chinook spawning habitat in the Bull Run system is limited to the short reaches below the dams on the Bull Run and Little Sandy rivers. At times, the streamflows in these reaches were low and may have limited spawning habitat.

EDT Modeling. Results from EDT modeling for the the Sandy River Basin estimate that the primary limiting factors for fall Chinook are as follows:

- <u>Habitat diversity</u>. Habitat diversity has decreased throughout the Basin, but the primary effects are found in the Bull Run and Zigzag rivers. The decrease has been caused by loss of large woody debris, artificial confinement of the stream channel, and degraded riparian condition.
- <u>Key habitat quantity</u>. Key habitat quantity has decreased due to changes in habitat composition (pools, riffles, and glide) between the current and historical conditions in the Bull Run River watershed, the lower Columbia River, and the Salmon River Watershed. The change in habitat types is due to the simplification of the stream channel caused by loss of large woody debris, increased confinement, and changes in low flow.
- <u>Maximum stream temperature</u>. Higher stream temperatures in the Sandy River mainstem and Bull Run River have reduced spring Chinook productivity compared with historical conditions.
- <u>Obstructions</u>. The Bull Run dams block spring Chinook access, and Marmot Dam has affected the downstream survival of juvenile fish.

Other minor limiting factors include changes in high and low flow, channel stability, and sediment throughout the Basin. The factors limiting spring Chinook production are shown in Figure 5-17.

	Limiting Factors															
Geographic Area	Channel Stability	Chemicals	Competition (hatch)	Competition (other species)	Flow	Food	Habitat diversity	Hasassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Bull Run River	●				•	•	⬤		⬤				●	●		●
Columbia River			•				•					●				⬤
Lower Sandy River	•				•	•	●	•					●	⬤		•
Middle Sandy River	•				•	•	•						•	•		•
Upper Sandy River	•				•	•	●						●	•		•
Salmon River	•				•	•	●							•		●
Zigzag River	•				•	•	⬤						•			•

Figure 5-17. Limiting Factors for Spring Chinook in the Sandy River Basin[a,b]

Percentage change from historical conditions	Worse
Less than 1%	
Between 1 and 5%	•
Between 5 and 20%	●
More than 20%	⬤

Source: EDT model run 10/20/2005.

[a]Appendix D provides definitions of the limiting factors (level 3 survival factors) and the habitat attributes (level 2 environmental attributes) and a matrix showing the relationship between them.

[b]The habitat attributes are also used in Chapter 8 and Appendix E to define the reference condition for the habitat benefits that arise from the City's HCP measures.

Spring Chinook in the Bull Run Watershed

Distribution

Spring Chinook currently have access to approximately 7.5 stream miles in the Bull Run watershed. Of this total, approximately 5.8 miles occur in the lower Bull Run River downstream of Headworks, with an additional 1.7 miles in the Little Sandy River downstream of the Little Sandy Dam site. Figure 5-18 shows the occurrence of spring Chinook life stages in the lower Bull Run River.

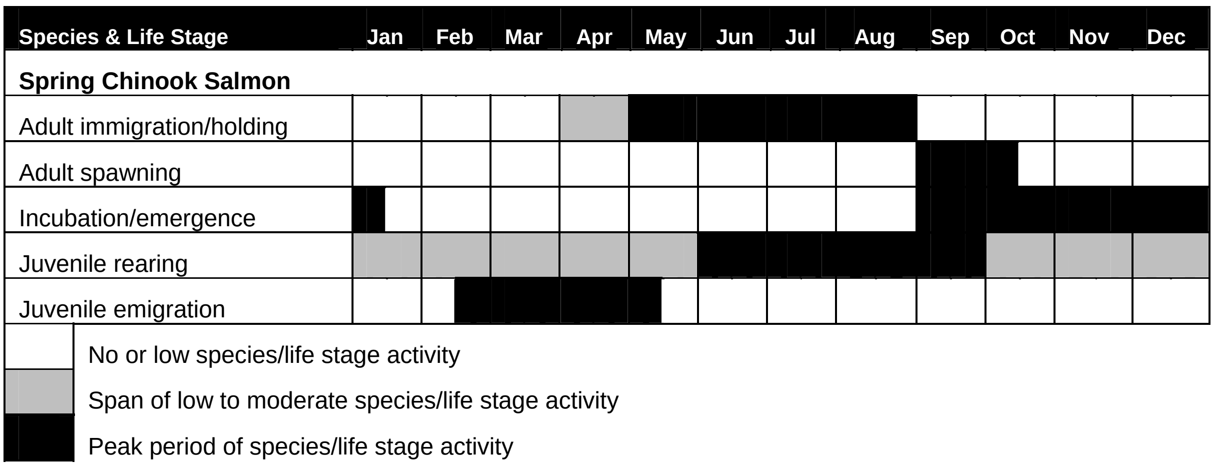


Figure 5-18. Estimated Periods of Occurrence for Spring Chinook in the Lower Bull Run River

Table 5-2 summarizes the river segments and historical distribution of spring Chinook in the Bull Run watershed. Figure 5-15 on page 5-30 shows historical spring Chinook distribution throughout the Sandy River Basin.

Table 5-2. Historical Distribution of Spring Chinook in the Bull Run and Little Sandy Rivers

River Segment	River Miles
Lower Bull Run River	
Bull Run River (mouth to Dam 2 spillway weir)	5.8
Upper Bull Run River	
Bull Run River (Dam 2 spillway weir up through reservoirs)	9.2
Bull Run River (free-flowing river to waterfall at RM 16.3)	1.3
South Fork Bull Run River	2.7
Cedar Creek (tributary to South Fork Bull Run River)	8.1
Little Sandy River	
Little Sandy River (mouth to Little Sandy Dam site)	1.7
Little Sandy River (Little Sandy Dam site to middle waterfalls)	5.6

Source: USFS, 1999

Even though 7.5 stream miles are accessible in the Bull Run watershed, spring Chinook do not currently use all of the habitat. On the mainstem Bull Run, Chinook (both spring and fall) have not been observed upstream of Larson's falls at RM 4.3 on the Bull Run River. The falls are passable at relatively small flows, but spring Chinook tend to stay in the lower river.

For the lower Little Sandy River downstream of the Little Sandy Dam site, current PGE operations significantly reduce base flows and little fish production occurs in this stream reach. With dam removal planned for 2008, base flows will revert to historical levels, but it is not known whether spring Chinook will use the Little Sandy River. The channel size, geomorphology, base flows, and other conditions may favor other fish species such as steelhead or coho salmon.

Abundance

Under current habitat conditions and access limitations, the EDT model estimates that the habitat in the Bull Run and Little Sandy rivers could produce approximately 60 spring Chinook adults annually assuming no harvest or hatchery fish influences. The EDT estimates of adult spring Chinook production are close to the numbers of fish observed in the Bull Run watershed. Clearwater Biostudies (2006) surveyed a total of 68 redds and estimated the minimum spawning escapement for the lower Bull Run River during the 2005 spawning period to be 232 adults. This total included primarily spring Chinook and perhaps some early fall Chinook salmon in a 2.4-mile reach between Larson's Bridge and the Bull Run Hydroelectric Project Powerhouse. The 2005 survey provided adult Chinook salmon abundances that exceeded the range of minimum spawning escapements of between 78 and 89 Chinook salmon spawners collected in the late 1990s (Beak 2000a; ODFW 2002). However, many of the spring Chinook observed in the lower Bull Run River were likely of hatchery origin, thus biasing upward the estimated spring Chinook production potential of the Bull Run watershed.

If habitat in the lower Bull Run and Little Sandy rivers were restored to historical habitat conditions (mid-1800s) and fish access above the Little Sandy Dam were restored, EDT projections indicate that spring Chinook adult and juvenile abundance could be increased to 1,785 adult spring Chinook and approximately 66,000 juvenile fish, respectively. This assumes, however, that environmental conditions (including harvest) in the lower Sandy River, lower Columbia River and estuary, and ocean have not been further degraded.

Habitat Conditions

The current habitat conditions of the lower Bull Run River do not favor utilization by spring Chinook. Various studies (Clearwater BioStudies 1997; R2 Resource Consultants 1998a,b; Beak 1999, 2000a) indicate that the following key environmental factors may have affected abundance and productivity of spring Chinook in the lower Bull Run River:

- Dams block access to potential upstream spawning habitat.
- High water temperatures during summer may affect juvenile fish growth and survival.
- High water temperatures during primary spawning time may affect adult spawning.

- Sustained summer low flows may reduce the amount of instream habitat suitable for use by juvenile spring Chinook.
- Gravel in the lower river suitable for spawning and construction of redds is lacking or absent.
- Rapid, short-term flow fluctuations may cause stranding or displacement of juvenile spring Chinook.

Several of the factors listed above result from the City's water supply operations in the Bull Run. However, some of the factors occur naturally and indicate spring Chinook production was likely limited historically by habitat conditions in the lower Bull Run. As an example, the summer and early fall water temperatures in the lower Bull Run River were high before the City constructed the dams (Leighton 2002). These high water temperatures probably limited the success of spring Chinook spawning and rearing in this portion of the Bull Run. Currently, it is not known whether significant spring Chinook production occurs. Spring Chinook adults are observed every year, but their spawning and rearing success have not been evaluated.

The presence of adult spring Chinook may be attributable to how PGE operates its Bull Run Hydroelectric Project. Many spring Chinook are probably drawn into the Bull Run because PGE diverts Sandy River water and puts it into the Bull Run River at RM 1.5. These operations may create false attraction for the adult spring Chinook and may explain the yearly observations of salmon in the lower Bull Run River.

Limiting Factors

Reach-specific results for spring Chinook salmon in the Bull Run River watershed are summarized in Figure 5-19. This summary indicates that the most affected life stages among the reaches in the watershed are emerging and dispersing fry (fry colonization), developing eggs (incubating eggs), and migrating adults (prespawning migrant), followed by holding adults (prespawning holding) and subyearling rearing (0-age active rearing).

Twelve of the 16 limiting factors affect spring Chinook survival in the watershed. Of these factors, channel stability, flow, food, habitat diversity, obstructions, sediment load, temperature, and key habitat quantity have a high to extreme effect in depressing productivity in most reaches of the Bull Run River watershed, excluding reach South Fork Bull Run 2.

	Life Stage Most Affected											
	Spawning	Egg incubation	Fry colonization	0-age active rearing	0,1-age inactive	1-age migrant	1-age active rearing	2+-age active rearing	2+-age migrant	2+-age transient rearing	Prespawning migrant	Prespawning holding
Bull Run Dam 1						3					1	
Bull Run Dam 2						3					1	
Bull Run Spillway Weir						3					1	
Bull Run 1	2	1										3
Bull Run 2	2	1										3
Bull Run 3	3	1		1								
Bull Run 4	3	2		1								
Bull Run 5						3					1	
Bull Run 6			2	3								1
Bull Run 6a		1	3									2
Cougar 1		3	1									2
Little Sandy 1			1	3	2							
Little Sandy 2		2	1									3
N.F. Bull Run 1		3	1									2
SF Bull Run 1			1	3								2
S.F. Bull Run 2			1	2	3							

	Limiting Factors															
	Channel stability	Chemicals	Competition (w/hatch)	Competition (other species)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Bull Run Dam 1									⬤							
Bull Run Dam 2									⬤							
Bull Run Spillway Weir									⬤							
Bull Run 1	⬤				●		•					◦	•	⚫		⚫
Bull Run 2	⬤				⚫		●					◦	●	⚫		●
Bull Run 3	⬤				●		•				•	◦	●	⚫		●
Bull Run 4	⬤				•	●	⚫				•		●	⚫		●
Bull Run 5									⬤							
Bull Run 6	●			•	●	⚫	⬤			•			⚫	•		◯
Bull Run 6a	●			•	●	⚫	⬤			●			⬤	●		⬤
Cougar 1	●				●	●	⚫									◯
Little Sandy 1	•				•	●	⚫									⚫
Little Sandy 2	•				⚫	●	⬤						⚫	●		
N.F. Bull Run 1	●			•	⚫	⚫	⬤									◯
SF Bull Run 1	●			•	⚫	⚫	⬤						⚫			◯
S.F. Bull Run 2						●										

Figure 5-19. Limiting Factors for Spring Chinook in the Bull Run River Watershed[a,b]

Percentage change from historical conditions	Worse	Better
Less than 0.2 %		
Between 1.0 and 0.2%	•	◦
Between 5 and 1%	●	○
Between 25 and 5%	⚫	◯
More than 25%	⬤	❍

Source: EDT model run 10/20/2005.

[a]Appendix D provides definitions of the limiting factors (level 3 survival factors) and the habitat attributes (level 2 environmental attributes) and a matrix showing the relationship between them.

[a]Bull Run reaches 5 and higher are the reaches at or above the Dam 2 diversion pool and include the reservoirs. The limiting factors in this figure for Bull Run reaches 5 and above are primarily the results of inundation of the Bull Run River by the reservoirs.

Flow and Spring Chinook Habitat Preferences

Because City operations in the Bull Run divert flow from the watershed, and that effect is a focus of this HCP, additional information on the relationship between streamflow and fish habitat preferences is provided below for Chinook salmon.

Spawning Flow-Habitat Relationships. Figure 5-20 shows the relationship between total usable habitat and flow for spawning Chinook salmon in the lower Bull Run River between Dam 2 (approximately RM 5.8) and PGE's powerhouse at RM 1.5. These relationships were developed for Chinook salmon and are applicable for both the fall and spring races of Chinook.

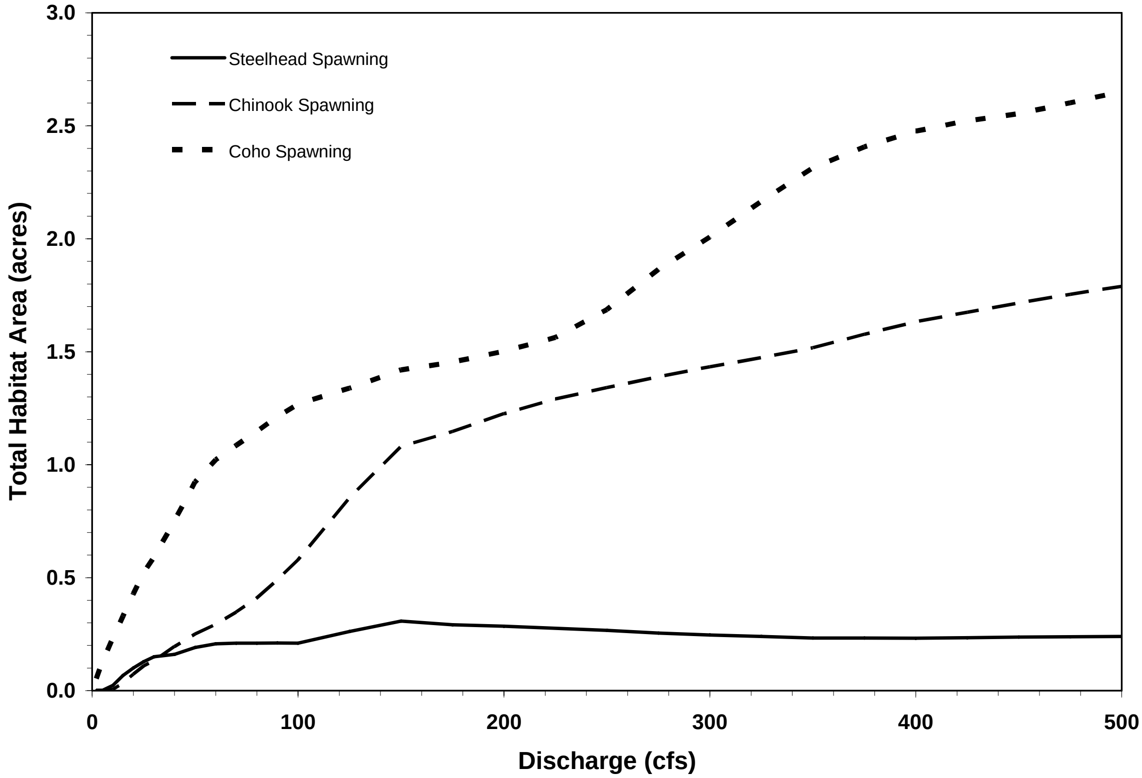


Figure 5-20. Relationship Between Flows in the Lower Bull Run River and Available Spawning Habitat for Chinook, Coho Salmon, and Steelhead

Source: R2 Resource Consultants 1998a.

Within the flow range modeled (0–500 cfs), the relationship for Chinook indicates that spawning habitat increases with increasing discharge.

Juvenile Rearing Flow-Habitat Relationships. Figure 5-21 shows the relationship between total usable habitat and flow for rearing juvenile Chinook in the lower Bull Run River.

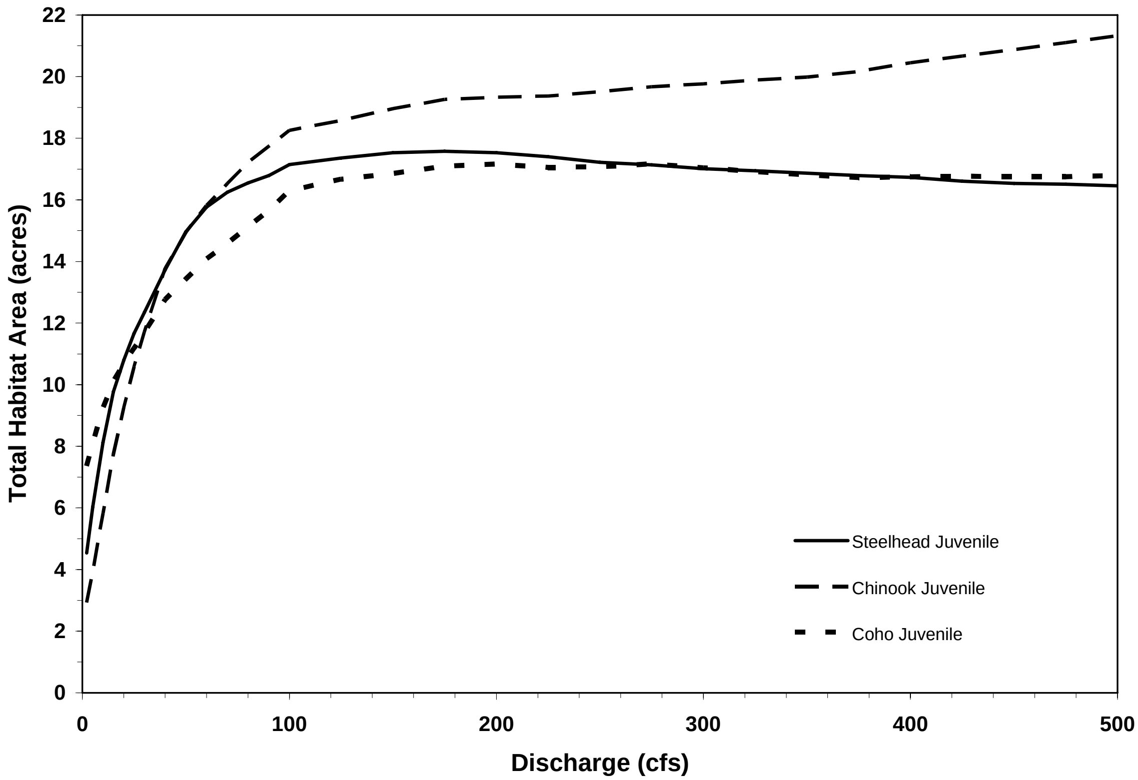


Figure 5-21. Relationship between Total Usable Habitat and Flow for Rearing Juvenile Chinook, Coho Salmon, and Steelhead in the Lower Bull Run River

Source: R2 Resource Consultants 1998a.

Results of PHABSIM modeling indicate that habitat conditions for juvenile Chinook salmon increase at a rapid rate between 0 and 100 cfs, with most of the rapid increase occurring between 0 and 20 cfs (R2 Resource Consultants 1998a). Habitat conditions for juvenile Chinook and other salmonids become near constant at flows above 100 cfs.

The results of the PHABSIM modeling are expressed as weighted usable area (WUA), an index of available instream habitat at various increments of flow. R2 Resources Consultants estimated WUA for a number of flows in various reaches of the lower Bull Run River by (1998a) using the PHABSIM model. The WUA estimates for each species are shown in Chapter 8, Effects of the HCP.

Winter Steelhead in the Sandy River Basin

Life History and Diversity

Winter-run steelhead trout (*O. mykiss*) are indigenous to the Sandy River Basin, and historical returns may have once numbered 20,000 adults (ODFW 2002). Recently, Sandy River winter steelhead abundance levels have fallen far below historical levels. In March 1998, they were listed as threatened under the federal ESA (NMFS 2003). Natural origin winter steelhead in the Sandy River Basin are included in the Lower Columbia River steelhead ESU.

Typically, winter-run steelhead native to the Sandy River enter the Basin in significant numbers from February through May, with a few fish still present in June. The majority of suitable spawning habitat is located upstream of the Marmot Dam site in the Salmon River and its tributaries and in Still Creek (PGE 2002). Spawning habitat is also present in Clear Creek, Clear Fork, Lost Creek, Horseshoe Creek, Zigzag River and Camp Creek (Bishop, pers. comm., 2004). Peak passage over Marmot Dam usually occurred in March and April (PGE 2002), with peak spawning occurring mid-March through mid-May (PGE 2002). Estimated periods of occurrence of winter steelhead life stages in the upper portion of the Sandy River Basin are shown in Figure 5-22.

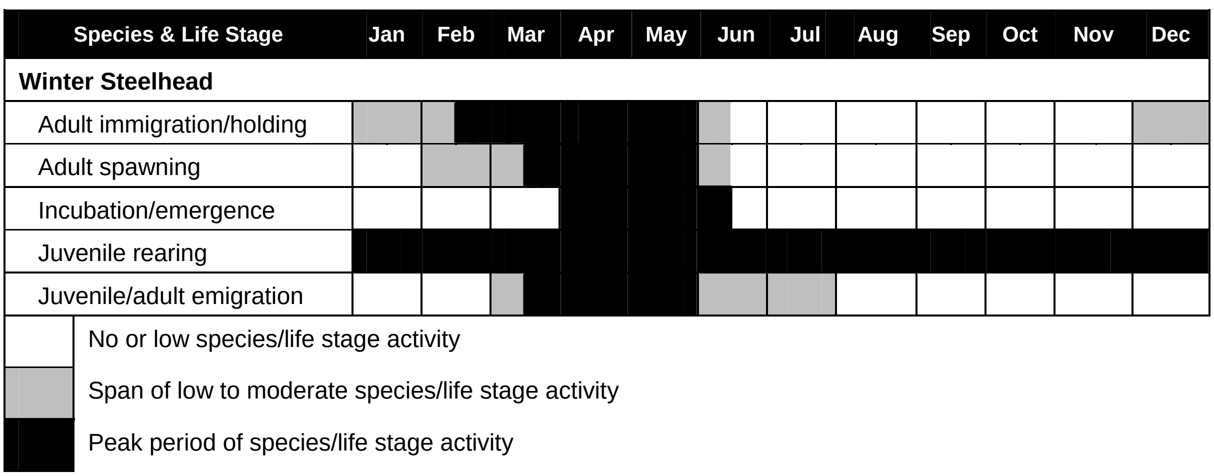


Figure 5-22. Estimated Periods of Occurrence for Steelhead in the Upper Sandy River Basin Above the Marmot Dam Site

Source: Sandy River Basin Agreement Technical Team 2002.

Fertilized winter steelhead eggs may incubate in the gravel for up to 50 days before hatching and an additional two to three weeks before emerging (ODFW 1997). Following emergence, steelhead fry will often seek refuge from fast currents by inhabiting stream margins and pool backwater habitats. As they begin to mature and grow larger, juveniles typically inhabit deeper water habitats of pools, riffles, and runs. PGE (2002) found that the preferred habitats for steelhead in the mainstem Sandy River are where large boulder substrates provide velocity refuge and optimal feeding conditions. Natural origin winter steelhead smolts in the Sandy River Basin emigrate to the ocean typically as age-2+ smolts in spring, but 3+ smolts are common (ODFW 1997).

Sandy River Basin winter steelhead usually spend two years in the ocean, but three-year ocean residence is common (ODFW 1997). Ocean distribution is poorly documented, but Sandy stock winter steelhead juveniles are believed to follow patterns similar to those followed by other Columbia River stocks (ODFW 1997). The NMFS WLC-TRT classified the winter run as a "core" population in its recovery planning efforts. This designation means the population historically was abundant and productive, and currently offers one of the most likely paths to recovery in the Lower Columbia Steelhead ESU (McElhany et al. 2003).

The LCRFRB delineated the priority for contribution of this stock to recovery goals in the ESU as "primary." This classification means the Sandy River winter steelhead stock would be targeted for recovery in the Cascade "stratum" to achieve viable population levels with greater than 95 percent probability of persistence (negligible extinction risk) within 100 years (LCRFRB 2004, McElhany et al. 2003; McElhany et al. 2004).

Distribution

The SRBTT developed a completed list of the reaches in which each natural population of anadromous salmonids was known or assumed to spawn, either currently or historically (City of Portland 2004a). For streams where data were not available to determine species use, the SRBTT assumed that steelhead would not utilize streams with a minimum width less than 8 feet or a gradient higher than 12 percent. After initial EDT model runs were completed in 2001, the SRBTT met again to review the results and re-examine spawning distribution in the Sandy River Basin. Based on this review, several spawning reaches were excluded for some species and added for others. This distribution information was used to develop Figures 5-23 and 5-24.

Current. Current winter steelhead distribution in the Sandy River Basin is shown in Figure 5-23. Native winter steelhead spawning and rearing in the Sandy River primarily occurs upstream of the Marmot Dam site. Lower Basin tributaries (below the Marmot Dam site) that may support additional winter steelhead production include the Bull Run River and Gordon, Trout, and Buck creeks (PGE 2002). Juvenile winter steelhead are likely present year-round throughout most of the Sandy River mainstem in both the upper and lower portions of the Basin. Natural production in the Bull Run and Little Sandy rivers and in Cedar and Alder creeks has been limited by a lack of fish passage into the upper reaches of the streams.

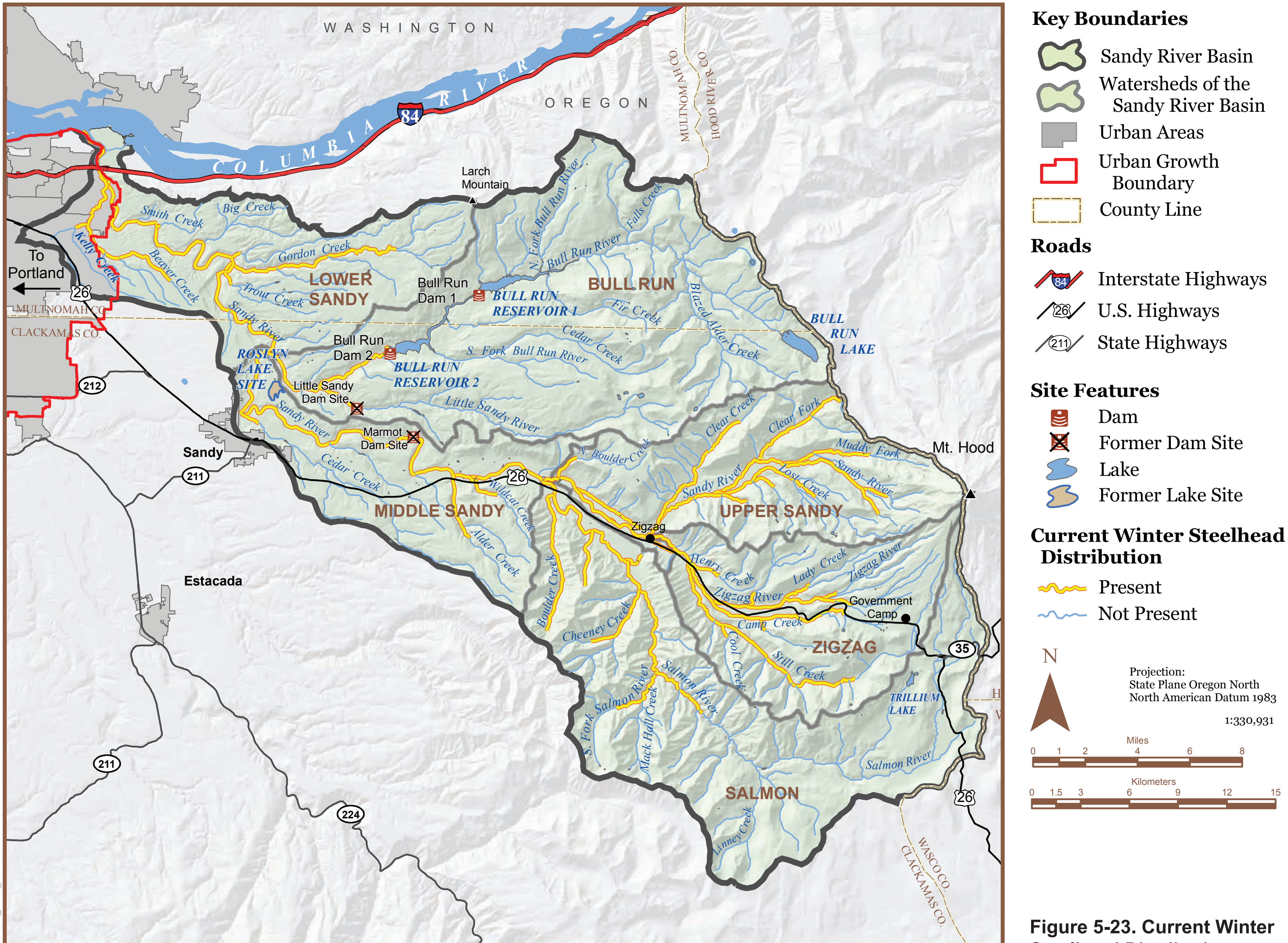
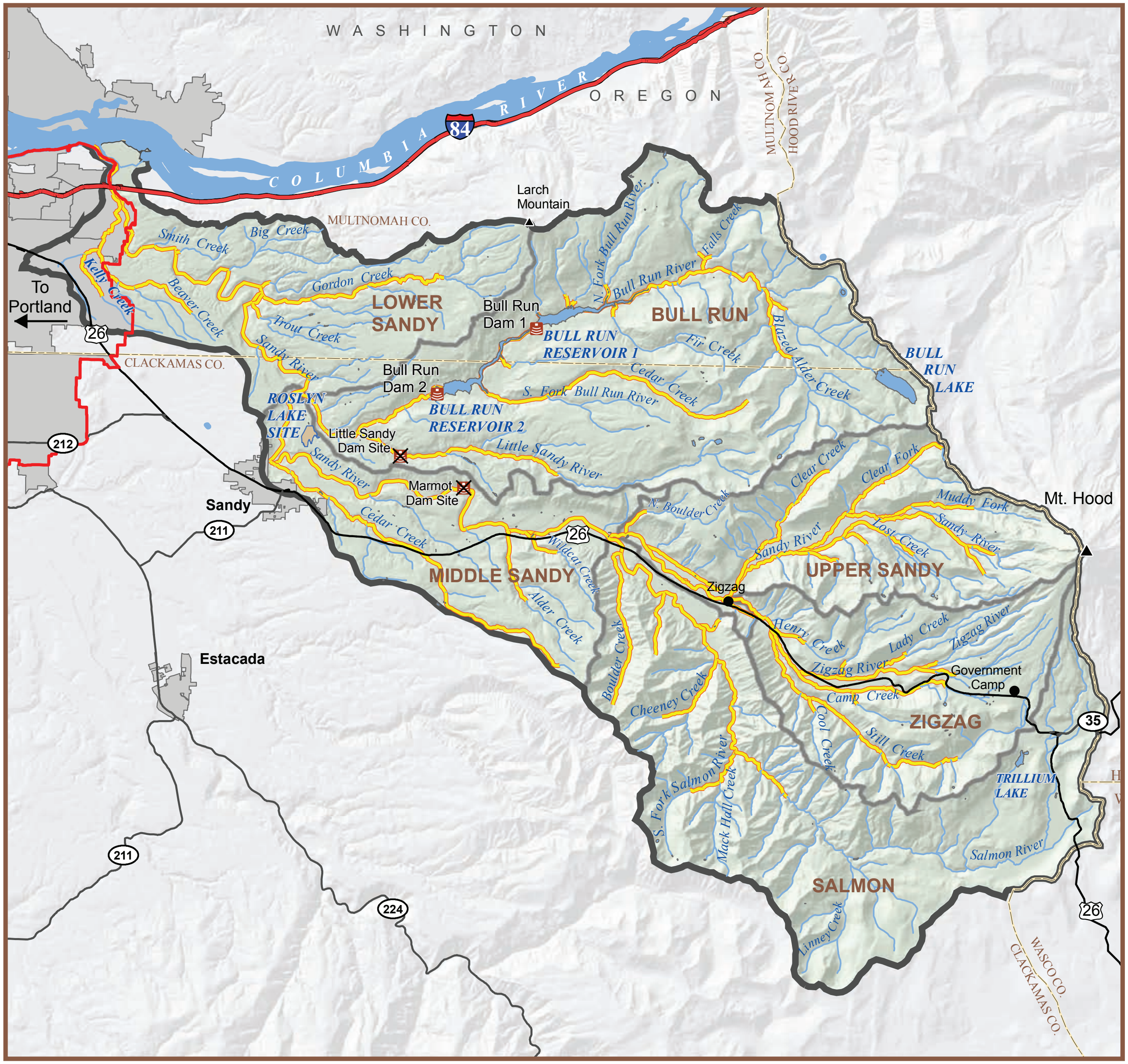


Figure 5-23. Current Winter Steelhead Distribution

Historical. Historical winter steelhead distribution assumed in the Sandy River Basin is shown in Figure 5-24. Historically, Sandy River Basin winter steelhead likely spawned and reared in many reaches of the Basin that are currently not available to anadromy. Winter steelhead runs historically occurred in the Bull Run, Little Sandy, Salmon, and Zigzag rivers (NMFS 2003). The upper Sandy River Basin currently supports the bulk of winter steelhead production in the Basin, and the majority of historical habitat in the upper Basin remains available for winter steelhead use.



Key Boundaries

- Sandy River Basin
- Watersheds of the Sandy River Basin
- Urban Areas
- Urban Growth Boundary
- County Line

Roads

- 84 Interstate Highways
- 26 U.S. Highways
- 211 State Highways

Site Features

- Dam
- Former Dam Site
- Lakes
- Former Lake Site

Historical Winter Steelhead Distribution

- Present
- Not Present

N

Projection:
State Plane Oregon North
North American Datum 1983

1:330,931

Miles: 0 1 2 4 6 8

Kilometers: 0 1.5 3 6 9 12 15

Figure 5-24. Historical Winter Steelhead Distribution

Anchor Habitat. Of the species analyzed, steelhead anchor habitat reaches are the most numerous and spatially diverse (SRBWG 2006). The anchor habitat analysis, which is based on current conditions, identified 22 widely spread anchor habitat reaches for steelhead in the Sandy River. This is not surprising because, historically, steelhead spawning and rearing was widely distributed throughout the Sandy River Basin, while today most of the productive habitat is upstream of the Marmot Dam site (ODFW 2001). The City considered the anchor habitat reaches for steelhead when choosing offsite areas (non-Bull Run) that should be emphasized for HCP conservation measures (see Chapter 7).

Steelhead anchor habitat reaches were identified in the following watersheds:

- Lower Sandy River: lower end of Trout Creek
- Middle Sandy River: mainstem Sandy River from Bull Run confluence to RM 24 (two miles upstream of the mouth of Cedar Creek), mainstem Sandy River from the Marmot Dam site to the mouth of the Salmon River, and the lower end of Wildcat Creek
- Upper Sandy River: mainstem Sandy River from the Salmon River confluence to the Zigzag River, the lower end of Clear Fork and the lower end of Lost Creek
- Bull Run River: lower Little Sandy River downstream of the Little Sandy Dam
- Salmon River: lower Salmon River downstream of Boulder Creek and the lower ends of Boulder Creek, Sixes Creek, and the South Fork Salmon River
- Zigzag River: the lower 10 miles of Still Creek

Abundance

Even though winter steelhead spawn in many reaches upstream and downstream of the Marmot Dam site, the primary population abundance indicator for Sandy River Basin natural-origin winter steelhead has been determined from Marmot Dam counts. Beginning in run year 1998, all hatchery steelhead collected at the Marmot Dam fish trap were recycled back downstream for increased sport fishing opportunities. Since 1998, only non-adipose-fin-clipped steelhead trout have been passed upstream. Winter steelhead total dam counts (including both the hatchery and wild components) for 1980–1989 averaged approximately 3,007 adults.

Three different estimates of winter steelhead abundance, both wild and hatchery fish, are graphically displayed in Figure 5-25. The high, low, and average counts were 2,916, 537, and 1,316 fish, respectively, for 1990–1999. Average total counts for 1990–1999 were about half of the counts for the previous decade. Average total counts for 2000–2002 showed a continuous decline to approximately 1,065 adults. With the 1998 establishment of wild steelhead sanctuary areas upstream of Marmot Dam, wild spawners passing above Marmot Dam in run years 1998–2002 averaged 818 adults.

ODFW established a long-term escapement goal (based on existing habitat conditions) in the Sandy River Basin of 1,677 natural-origin spawners per year to maximize the number of adults returning to the Basin (NMFS 2003). The objective in the Oregon Administrative Rules (OAR 635-500-3430) is to rebuild the native winter steelhead runs in the Sandy Basin to achieve an average annual spawning escapement of 1,730 wild winter steelhead. The ODFW

Fisheries Management and Evaluation Plan (2003b) established a viable abundance threshold of Sandy River winter-run steelhead of 336 natural-origin spawners per year (20 percent of the maximum seeding). The critical abundance threshold (set to avoid short-term deleterious genetic and demographic effects) was set at 82 natural origin spawners per year (ODFW 2003b).

EDT estimates of adult production were also determined based on the same geographic point of reference (all reaches upstream of Marmot Dam site counts) as was used for the empirical abundance estimates shown in Figure 5-25. EDT estimated current adult steelhead production above the Marmot Dam site at approximately 2,300 adult fish. The EDT estimate assumed the harvest rate on wild steelhead was 10 percent in the 1990s. For the fully restored freshwater habitat condition, winter steelhead abundance was estimated at about 3,800 adult spawners.

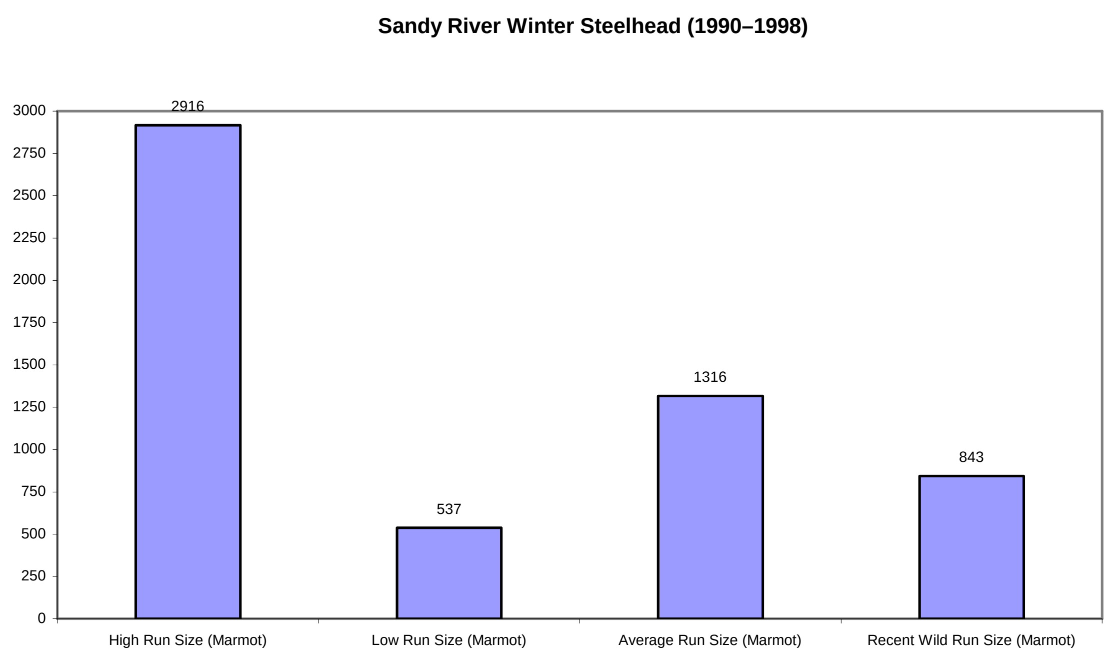


Figure 5-25 Estimates of Winter Steelhead Abundance Upstream of Marmot Dam

Source: ODFW 2003a

The average adult run size observed at Marmot Dam for both hatchery and wild fish combined between 1990 and 1998 (1,316) is less than the EDT prediction of adult returns to this same point. However, the EDT estimate does not exceed the highest number of adults observed (2,916) at Marmot Dam from 1990 to 1998. It should be noted that the dam counts did not separate hatchery and wild fish in some years. From 1990–2000, the number of wild steelhead passing Marmot Dam was estimated at 932 fish (ODFW Fisheries Management and Evaluation Plan 2003b).

Hatchery Production and Plantings

Current. Winter steelhead hatchery programs in the Sandy River Basin have been altered recently to use in-basin brood stock derived from the local wild population. Beginning in brood year 2000, all adult steelhead brood stock collected for hatchery supplementation has been wild fish with an intact adipose fin collected at the Marmot Dam fish trap (NMFS 2003). From brood years 2002–2007, brood stock has been collected from adults returning to Sandy Hatchery and supplemented with wild stock collected at Marmot Dam (no more than 30 percent of annual brood goal) (Bourne pers. comm, 2004; Stahl pers. comm, 2004). The last year for out-of-Basin winter steelhead smolt releases in the Sandy River Basin occurred in 2001; 40,000 Big Creek smolts were released with 118,000 Sandy stock smolts (Bourne pers. comm, 2004). Returning Sandy stock hatchery adults were differentiated from Big Creek adults by the marking of the right maxillary and adipose fins; hatchery Sandy stock has marked adipose fin only (Bourne pers. comm, 2004). In 2002, 162,000 Sandy stock winter steelhead smolts were released; in 2003, 179,000 winter steelhead smolts were released (Bourne pers. comm, 2004).

Historical. Hatchery winter steelhead egg-take and supplementation programs began in the Sandy River Basin in 1896, when winter steelhead eggs were collected at a hatchery on Boulder Creek, a tributary to the lower Salmon River (ODFW 1997). Following the construction of Marmot Dam in 1912, hatchery operations were moved to a site downstream of the dam and continued there from 1913 to 1954 (ODFW 1997). Fish were trapped at this site until 1951, primarily because the Marmot Dam diversion canal was unscreened up to this point. It is likely that a large percentage of fingerlings and smolts released upstream of Marmot Dam prior to 1951 would have been diverted into Roslyn Lake and PGE's Bull Run Hydroelectric Project.

A more focused hatchery smolt release program began in 1955, with the majority of smolts consisting of Big Creek (1955–2000) and Eagle Creek (1986–2000) hatchery stocks. Additional stocks released intermittently throughout the period 1955–2000 included Alsea River, Sandy River, and Cedar Creek stocks. Smolt releases from 1955–1960 remained below 100,000 winter steelhead annually; from 1961 to 1996, smolt releases increased substantially and varied from a low of 119,032 in 1982 to a high of 231,583 in 1994 (ODFW 1997). From 1989 to 2007 when Marmot Dam was decommissioned, all hatchery winter steelhead were released below Marmot Dam to concentrate angler effort and reduce impacts to wild fish spawning upstream (ODFW 1997).

Harvest in the Basin

Current. Current harvest impacts to Sandy River Basin winter steelhead trout have been greatly reduced since the implementation of a marked selective fishery in 1992. Wild steelhead release regulations implemented in 1992 allow only adipose-fin-clipped steelhead of hatchery origin to be retained. Wild steelhead fishery mortality rates in the Sandy River Basin were estimated to be in the range of 40 percent prior to 1992 (Chilcote 2001; as cited in ODFW 2003b). NMFS (2003) and ODFW (2003b) estimate annual harvest impacts to be 2.0 to 2.5 percent of the natural-origin steelhead returning to the ESU, based on the assumed post-release mortality rate of 5 percent and a maximum fishery encounter rate of 40 percent. This estimate also takes into consideration an assumed 90 percent angler compliance with releasing natural origin sport-caught fish (ODFW 2003b).

Regulations implemented in 1999 created a sanctuary area for steelhead upstream of Marmot Dam and limited sport harvest to downstream of Marmot Dam. Beginning in 1998, all adipose-fin-clipped hatchery fish were to be recycled downstream for increased angler opportunity in the lower Basin, where recreational fishing effort is concentrated (PGE 2002).

Historical. Historical sport harvest of wild and hatchery winter steelhead (from ODFW 2001) varied greatly from 1955 to 1992. Total sport catch ranged from a low of 1,903 in 1960–1961, to a high of 13,000 in 1979–1980. Sport catch estimates are complete through run year 1996–1997. Sport catch in the Sandy River Basin for the 5 years (1987–1991) prior to the wild steelhead release regulation averaged 7,511. Comparatively, the average sport catch for the 5 years (1992–1996) after the wild steelhead release regulation was 2,347.

Reasons for Listing/Threats to Survival

Three sources of information are available to help explain the reasons winter steelhead have decreased in abundance in the Sandy River Basin: NMFS documents, ODFW reports, and EDT model results, as discussed below.

National Marine Fisheries Service. NMFS identified destruction and modification of habitat, overutilization for recreational purposes, and natural and human-made factors as the primary reasons for the decline of west coast steelhead (NMFS 1998b). Specifically for the Lower Columbia River ESU, NMFS identified the following factors contributing to the decline of steelhead: competition and interbreeding with hatchery fish; impeded access to habitat; hydropower development; logging; predation; and harvest (NMFS 1998b). Natural

Photo courtesy of Bonneville Power Administration.

origin steelhead trout were often caught incidentally in spring Chinook fisheries in the mainstem Columbia River due to their coinciding run timing. A 20-year trend in poor ocean conditions further exacerbated the problem of depressed returns in the ESU.

Oregon Department of Fish and Wildlife. The Sandy Basin Management Plan (ODFW 1997) identified the following factors in reducing the production potential of native winter steelhead in the Sandy River Basin (though it is possible some of the listed factors no longer affect current populations):

- Poor ocean conditions
- Reduction in historical habitat in the Bull Run River watershed by construction of dams
- Lack of screening at the water diversion canal at Marmot Dam that likely entrained many outmigrating, naturally produced smolts prior to 1951
- Channelization of many miles of important winter steelhead spawning and rearing habitat in the Basin following the 1964 flood
- Wild steelhead trapping and egg-take operations in the Salmon River Basin and at Marmot Dam prior to 1951
- Recreational overharvest of wild winter steelhead prior to the implementation of catch-and-release in 1990
- Hatchery practices that have led to increased competition and possible genetic introgression between out-of-basin hatchery steelhead stocks and native Sandy steelhead stocks
- Commercial harvest of steelhead in the mainstem Columbia River until 1974

Ecosystem Diagnosis and Treatment. Results from EDT modeling for the Sandy River Basin estimate that the primary limiting factors for winter steelhead are the following:

- <u>Habitat diversity</u>. Loss in habitat diversity was found to be affecting steelhead production in the Salmon and Bull Run rivers. The loss was due to decreased riparian function, increased artificial stream confinement of the channel, and decreased large woody debris.
- <u>Key habitat quantity</u>. Key habitat quantity has decreased due to changes in habitat composition (pools, riffles, and glides).
- <u>Sediment</u>. Sediment has increased throughout most of the Basin due to decreased riparian habitat quality, landslides, and land practices.
- <u>Obstructions</u>. Dams on the Bull Run River, Little Sandy River, Cedar Creek, and mainstem Sandy River (Marmot) have affected steelhead passage and survival.

Other minor limiting factors include changes in both high and low flow, competition with hatchery fish, and channel stability in the lower Sandy River. The factors limiting winter steelhead production are shown in Figure 5-26.

	Limiting Factors															
Geographic Area	Channel Stability	Chemicals	Competition (hatch)	Competition (other species)	Flow	Food	Habitat diversity	Hasassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Bull Run River					•	•	●		⬤				●	•		●
Columbia River			•				•					•				•
Lower Sandy River	•				•	•	●	•			•	•	●	•		•
Middle Sandy River					•	•	•		⬤				•			•
Upper Sandy River					•		•						●			•
Salmon River					•		•					•				●
Zigzag River					•		•						•			•

Figure 5-26. Limiting Factors Affecting Winter Steelhead in the Sandy River Basin[a,b]

Percentage change from historical conditions	Worse
Less than 1%	
Between 1 and 5%	•
Between 5 and 20%	●
More than 20%	⬤

Source: EDT model data run 10/20/05.

[a]Appendix D provides definitions of the limiting factors (level 3 survival factors) and the habitat attributes (level 2 environmental attributes) and a matrix showing the relationship between them.

[b]The habitat attributes are also used in Chapter 8 and Appendix E to define the reference condition for the habitat benefits that arise from the City's HCP measures.

Winter Steelhead in the Bull Run Watershed

Distribution

Steelhead currently use about 7.5 stream miles of stream habitat in the Bull Run River watershed. Fish passage is blocked at RM 5.8 on the lower Bull Run River and at RM 1.7 on the Little Sandy River. Other tributaries to the lower Bull Run River have limited productivity potential for anadromous fish because of steep gradients or natural waterfalls

(City of Portland 2002). Additionally, a culvert barrier in Walker Creek blocks access to about 800 feet of this lower Bull Run River tributary (City of Portland 2002).

Historically, steelhead probably used about 49 stream miles in the Bull Run River watershed, which includes 10 miles of stream for the Little Sandy River. Of the 39 stream miles for the Bull Run portion, approximately 9 miles are now inundated by Bull Run reservoirs.

Table 5-3 summarizes the river segments and historical distribution of winter steelhead in the Bull Run watershed. Figure 5-24 on page 5-47 shows historical steelhead distribution throughout the Sandy River Basin.

Table 5-3. Historical Distribution of Steelhead in the Bull Run River

River Segment	River Miles
Lower Bull Run River	
Bull Run River (mouth to Dam 2 spillway weir)	5.8
Walker Creek	0.15
Little Sandy River (mouth to Little Sandy Dam site)	1.7
Little Sandy River (Little Sandy Dam site to middle waterfalls)	5.6
Little Sandy River Tributaries (upstream of Little Sandy Dam site)	2.0 (est.)
Upper Bull Run River	
Bull Run River (Dam 2 spillway weir up through reservoirs)	9.2
Bull Run River (free-flowing river to waterfall at RM 16.3)	1.3
South Fork Bull Run River	2.7
Bull Run River (RM 16.3 to 80’ waterfall at RM 21.4)	5.4
Cedar Creek (tributary to South Fork Bull Run River)	8.1
Camp Creek	0.6
Fir Creek	0.5
Bear Creek	0.3
Cougar Creek	0.7
North Fork Bull Run River	0.8
Log Creek	0.2
Falls Creek	0.8
West Branch Falls Creek	0.3
Blazed Alder Creek	2.4
Blazed Alder Tributaries	0.4 (est.)
Deer Creek	0.5

Source: USFS, 1999

Figure 5-27 shows the estimated periods of occurrence for steelhead in the lower Bull Run River.

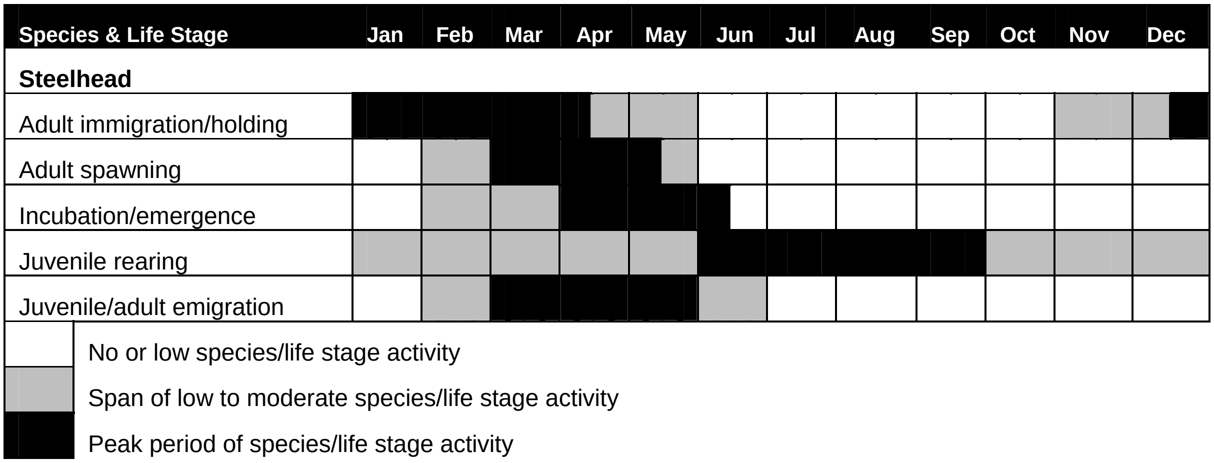


Figure 5-27. Estimated Periods of Occurrence for Steelhead in the Lower Bull Run River

Source: Sandy River Basin Agreement Technical Team 2002.

Abundance

The Sandy River EDT model estimates the habitat conditions that support adult abundance. For current and historical winter steelhead production in the lower Bull Run and Little Sandy rivers, the EDT estimates are 97 and 564 adults, respectively. Juvenile steelhead production for these same time frames was approximately 1,500 and 7,600.

Based on available substrate characteristics, R2 Resource Consultants (1998) estimated a spawning capacity in the lower Bull Run River of 96 redds, or approximately 192 spawners (1:1 female to male ratio). From 1997–2000, the average abundance of age-1+ and age-2+ juvenile steelhead was estimated at 2,393 (Beak 2000b). This abundance estimate is higher than the EDT estimates (2,393 versus 1,500), but as was the case with spring Chinook, the numbers are likely inflated by the presence of hatchery fish spawning in the watershed.

Habitat Conditions

Various studies (Clearwater BioStudies 1997; R2 Resource Consultants 1998 a,b; Beak 1999, 2000a) indicate that the following key environmental factors may have affected abundance and productivity of steelhead in the lower Bull Run River:

- Dam and culverts block access to potential upstream spawning habitat.
- High water temperatures during summer may affect juvenile fish growth and survival.
- Sustained summer low flows may reduce the amount of instream habitat suitable for use by juvenile steelhead.
- Gravel in the lower river suitable for spawning and construction of redds is lacking or absent.
- Rapid, short-term flow fluctuations may strand or displace juvenile steelhead.

Limiting Factors

The City used the EDT model to determine the limiting factors affecting steelhead production in the Bull Run River watershed. Reach-specific results for steelhead in the Bull Run River watershed are summarized in Figure 5-28. This summary indicates that the most affected life stages among the reaches in the watershed are emerging and dispersing fry (fry colonization), overwintering juveniles (0,1-age inactive), and juvenile rearing (0,1-age active rearing), followed by migrating adults (prespawning migrant) and developing eggs (egg incubation).

Thirteen of the 16 limiting factors affect steelhead survival among the reaches in the watershed. Of these, flow, habitat diversity, obstructions, sediment load, temperature, and key habitat quantity have a high effect in depressing productivity in some of the lower Bull Run River reaches (Little Sandy 2 and South Fork Bull Run 2).

	Life Stage Most Affected													Limiting Factors															
	Spawning	Egg incubation	Fry colonization	0-age migrant	0-age active rearing	0,1-age inactive	1-age migrant	1-age active rearing	2+-age active rearing	2+-age migrant	2+-age transient rearing	Prespawning migrant	Prespawning holding	Channel stability	Chemicals	Competition (w/hatch)	Competition (other species)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Blazed Alder 1			1		2	3		3											•										
Bull Run Bear 1		3	1		2									●			•	●	●	⚫									⬤
Bull Run Camp 1		2	1		3									●			•	●	●	●							•		◯
Bull Run Cedar 1					2	1		1										•	•	•									
Bull Run Dam 1							3			2		1										⬤							
Bull Run Dam 2							3			2		1										⬤							
Bull Run Spillway Weir							3			2		1										⬤							
Bull Run 1		3			1			2										•	•	•				●			⚫		●
Bull Run 2		3			1	3		2						●				⚫	•	●				●		•	⚫		●
Bull Run 3		3			1			2										●	•					●		•	⚫		●
Bull Run 4					2	2		1						•		•		⚫	●	⚫				●		•	⚫		•
Bull Run 5							3			2		1										⬤							
Bull Run 6						1		3						•		•		●	●	●						⬤	∘		◯
Bull Run 6a		1	3					2						●		•		●	●	●			•			⬤	●		●
Bull Run 7			2			1		1											•						∘				
Bull Run 8						1		1											•										
Bull Run 9			1		2	2													•										
Bull Run 10			1		2			3											•										
Cougar 1			1		2	3							3	•		•		●	●	●									○
Cougar 2			1			1		2						•				•	●	•									
Deer 1			1		2							3		●		•	•	⚫	⚫	⚫									◯
Deer 2	1	2	3																										⬤
Falls Creek 1			1		2			3											•										
Fir 1			1		2			3											•										
Little Sandy 1					1	2								•				●	•	●									●
Little Sandy 2		1				1		2						•				⚫	•	●						⚫	•		
N.F. Bull Run 1			1		2	3		3						●		•	•	●	●	●					∘				◯
N.F. Bull Run 2						1		3						•				●	•	●									○
SF Bull Run 1		3				1								•			•	⚫	●	⚫					∘	⬤			◯
S.F. Bull Run 2						1		3											•										

Figure 5-28. Limiting Factors for Winter Steelhead in the Bull Run River Watershed[a,b]

Percentage change from historical conditions	Worse	Better
Less than 0.2 %		
Between 1.0 and 0.2%	•	∘
Between 5 and 1%	●	○
Between 25 and 5%	⚫	◯
More than 25%	⬤	⭘

Source: EDT model run 10/20/05.

[a]Appendix D provides definitions of the limiting factors (level 3 survival factors) and the habitat attributes (level 2 environmental attributes) and a matrix showing the relationship between them.

[a]Bull Run reaches 5 and higher are the reaches at or above the Dam 2 diversion pool and include the reservoirs. The limiting factors in this figure for Bull Run reaches 5 and above are primarily the results of inundation of the Bull Run River by the reservoirs.

Flow and Steelhead Habitat Preferences

Because City operations in the Bull Run divert flow from the watershed, and that effect is a focus of this HCP, additional information on the relationship between streamflow and fish habitat preferences is provided below for steelhead.

Spawning Flow-Habitat Relationships. Figure 5-29 shows the relationship between total usable habitat and flow for spawning winter steelhead in the lower Bull Run River between Dam 2 (approximately RM 5.8) and PGE's powerhouse at RM 1.5. These relationships were developed for Chinook salmon and are applicable to Chinook salmon, steelhead, and coho salmon.

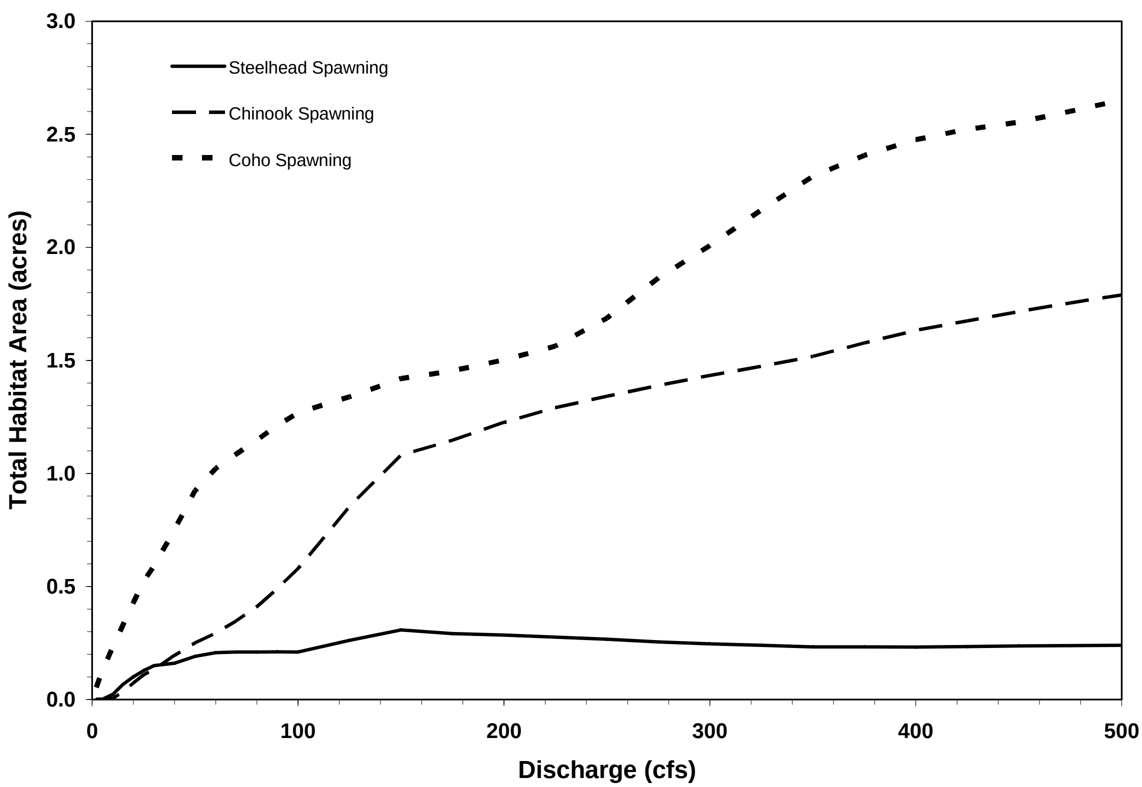


Figure 5-29. Relationship Between Flows in the Lower Bull Run River and Available Spawning Habitat for Chinook, Coho Salmon, and Steelhead

Source: R2 Resource Consultants 1998a.

Within the flow range modeled (0–500 cfs), the relationship for steelhead indicates that spawning habitat increases with increasing discharge.

Juvenile Rearing Flow-Habitat Relationships. Figure 5-30 shows the relationship between total usable habitat and flow for rearing juvenile steelhead in the lower Bull Run River.

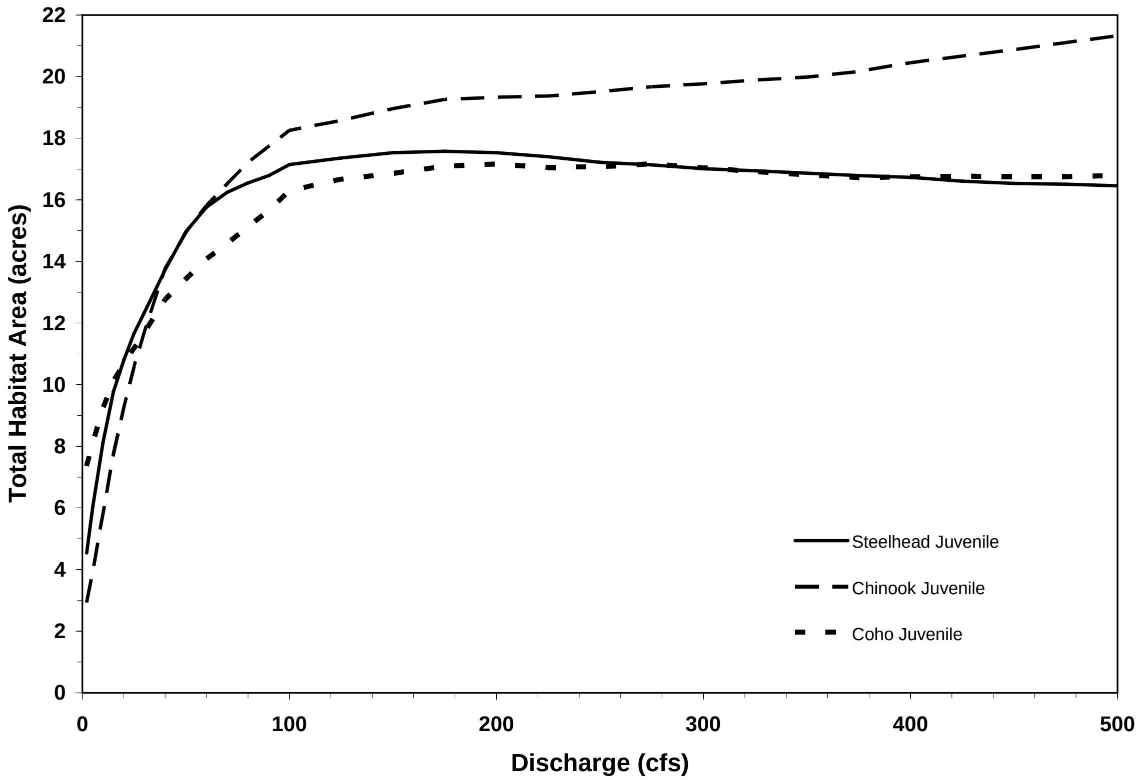


Figure 5-30. Relationship between Total Usable Habitat and Flow for Rearing Juvenile Steelhead in the Lower Bull Run River

Source: R2 Resource Consultants 1998a.

Results of PHABSIM modeling indicate that habitat conditions for juvenile steelhead increase at a rapid rate between 0 and 100 cfs, with most of the rapid increase occurring between 0 and 20 cfs (R2 Resource Consultants 1998a). Habitat conditions for juvenile steelhead and other salmonids become near constant at flows above 100 cfs.

The results of the PHABSIM modeling are expressed as weighted usable area (WUA), an index of available instream habitat at various increments of flow. R2 Resources Consultants estimated WUA for a number of flows in various reaches of the lower Bull Run River by (1998a) using the PHABSIM model. The WUA estimates for each species are shown in Chapter 8, Effects of the HCP.

Coho in the Sandy River Basin

Life History and Diversity

Coho salmon (*O. kisutch*) in the Sandy River Basin belong to the Lower Columbia River ESU, and are listed as threatened under the ESA (June 2005). The Lower Columbia River ESU is sustained primarily by hatchery production. The only two known self-sustaining populations in the ESU include the Sandy and the Clackamas rivers in Oregon (NMFS 2003). Weitkamp et al. (1995) theorized that the only known remaining natural population of coho in the Lower Columbia River ESU is the Clackamas late-run stock. From 1999 to 2007, only natural-origin coho salmon were allowed to pass over Marmot Dam, and a naturally spawning population appears to exist.

Currently, the Sandy River Basin supports both an early hatchery run of coho—with peak presence occurring in September and October—and a late wild run generally peaking from September through November (ODFW 1997). Estimated periods of occurrence of coho life stages in the upper Sandy River Basin are shown in Figure 5-31.

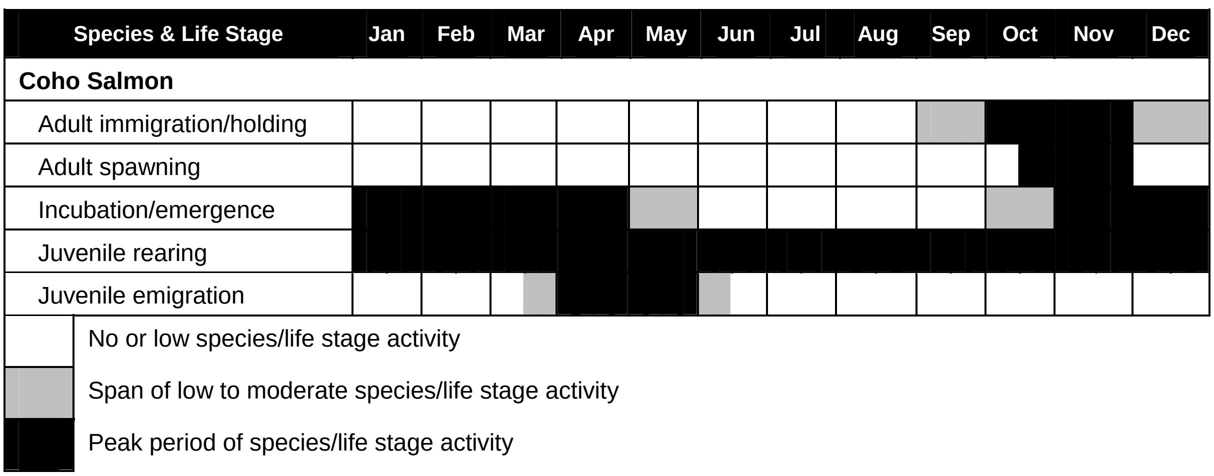


Figure 5-31. Estimated Periods of Occurrence for Coho in the Upper Sandy River Basin Above Marmot Dam

Source: Sandy River Basin Agreement Technical Team 2002.

Historically, the late wild Sandy coho salmon were thought to have been present in the Basin primarily from October through February, with peak spawning occurring in November through February (ODFW 2002). ODFW (1997) lists two possible factors for the possible shift in run timing of wild coho in the Sandy River Basin: inconsistent flow regimes at Marmot Dam throughout the late summer and early fall from the early 1900s through the early 1970s; and possible genetic introgression with early returning hatchery fish escaping to spawning grounds upstream of the Marmot Dam site.

Migration of natural-origin coho salmon into the upper Basin for spawning in run years 1999–2003 showed a peak in passage at Marmot Dam during October. The average passage per year in October was 405 adults. The corresponding figures for September and November were 132 and 153 adults, respectively. Peak spawning activity in the Sandy River Basin occurs in late October through November, with very few fish observed on the spawning grounds after December (ODFW 1997).

Duration of egg incubation and fry emergence of coho salmon is greatly affected by water temperature, but generally takes between two and three months (ODFW 1997). Emergence primarily occurs from February through April and peaks in March (PGE 2002). Following emergence, juvenile coho salmon typically seek stream margin habitats and backwater pools for initial rearing (ODFW 1997). As they continue to grow in size, juveniles seek low-velocity pool and off-channel habitats for summer and winter rearing. Juvenile coho favor slack water habitats with complex large woody debris for protection from winter freshets.

Juvenile coho in the Sandy River typically emigrate to the ocean as age-1+ smolts at about 12 to 14 months of age (ODFW 1997). The timing of juvenile coho outmigration is usually late March through June, peaking in April and May (ODFW 1990). Coho salmon in the Lower Columbia River ESU generally rear in the ocean for two summers and return as three year olds. The primary exception are "jacks," sexually mature males that return to fresh water after spending one summer in the ocean (NMFS 2003).

Since coho salmon have only recently been listed in the Lower Columbia River ESU under the ESA, there is no WLC-TRT designation of populations as yet. Given the current low numbers of coho populations throughout the ESU, coho salmon viability will rely heavily on the natural populations in the Sandy and Clackamas rivers.

The LCRFRB designated the priority for contribution of this stock to meet recovery objectives in the ESU as "Primary." This classification means the Sandy River coho stock could be targeted to achieve viable population levels with greater than 95 percent probability of persistence (negligible extinction risk) within 100 years (LCRFRB 2004).

Distribution

The SRBTT developed a completed list of the reaches in which each natural population of anadromous salmonids was known or assumed to spawn, either currently or historically (City of Portland 2004). After initial EDT model runs were completed in 2001, the SRBTT met again to review the results and reexamine spawning distribution in the Sandy River Basin. Based on this review, several spawning reaches were excluded for some species and added for others. This distribution information was used to develop Figures 5-32 and 5-33.

Current. Current coho salmon distribution in the Sandy River Basin is shown in Figure 5-32. The majority of suitable coho spawning and rearing habitat in the Sandy River is located upstream of the Marmot Dam site in the mainstem Sandy River, in the Salmon River and its tributaries below Final Falls, and in Still Creek (ODFW 1997; PGE 2002). Lower Basin tributaries that could support coho salmon include Cedar, Trout, Beaver, Gordon, and Buck creeks (ODFW 2002; Brown, pers. comm., 2004) and the Bull Run River. Natural production in the Bull Run River and in Cedar Creek is limited by blocked fish passage into the upper reaches of the streams. Additional small tributaries may support coho production in some years. Many of the coho entering lower Basin tributaries below the Marmot Dam site are likely strays from Sandy Hatchery (ODFW 1997).

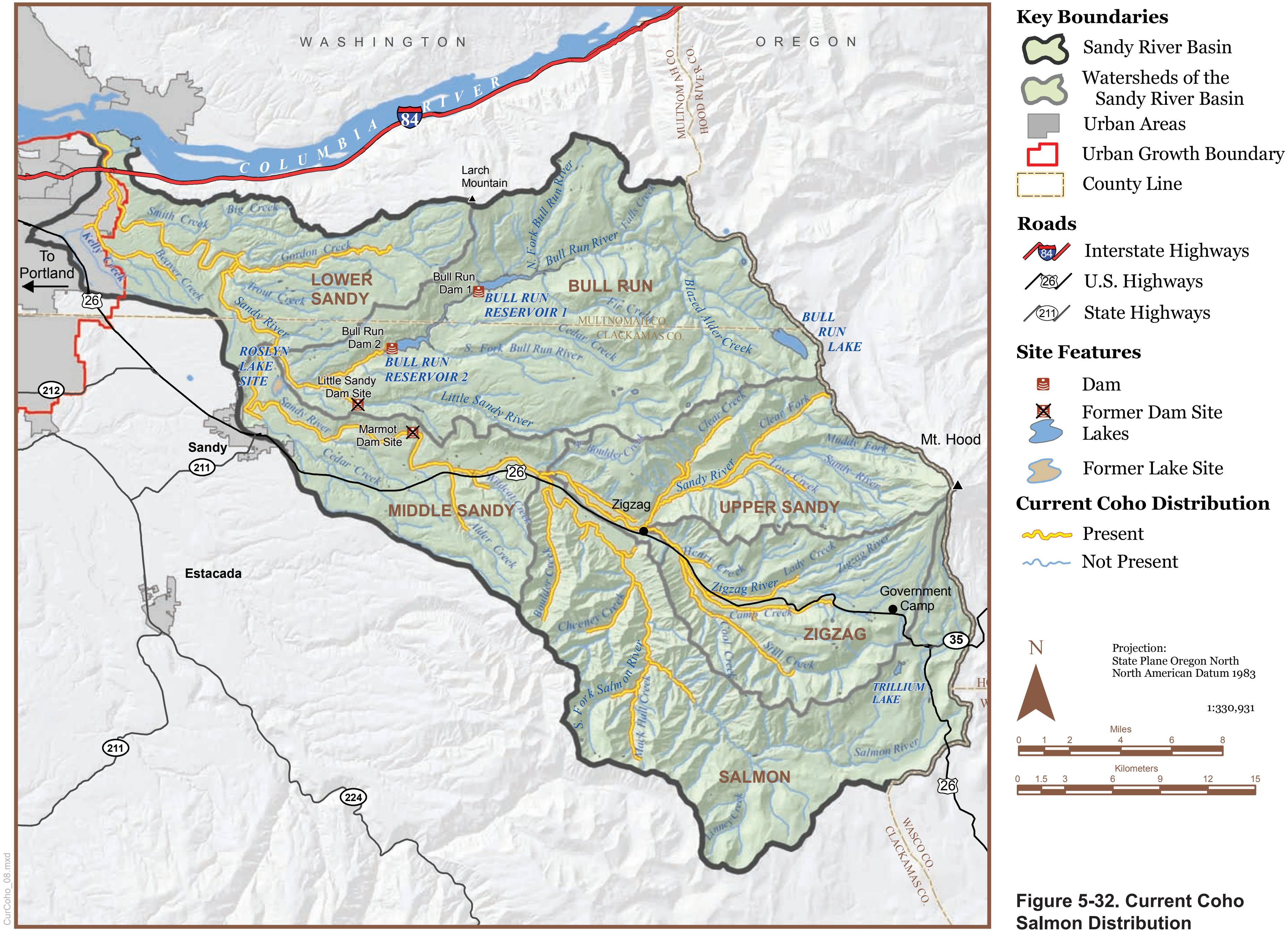


Figure 5-32. Current Coho Salmon Distribution

Historical. Historical coho salmon distribution assumed in the Sandy River Basin is shown in Figure 5-33. Historically, Sandy River Basin coho salmon likely spawned and reared in the majority of the Basin and its tributaries accessible to anadromous fishes. Similar to the current distribution, the major clear water tributaries above the Marmot Dam site (Salmon River, Boulder, Clear, Camp, Lost, and Still creeks, and Clear Fork) were likely important coho producers. Tributaries downstream of the Marmot Dam site were also likely important to coho production.

Anchor Habitat. The anchor habitat analysis—which is based on habitat that is currently accessible to anadromous fish conditions—found that the majority of the coho anchor habitat reaches are located in the upper Sandy River watershed upstream of the confluence of the Sandy and the Salmon rivers. One anchor habitat reach is on lower Gordon Creek, which is in the lower Sandy River watershed. The mainstem Salmon River up to Cheney Creek and the lower portions of Wee Burn, Sixes, and Cheney creeks are all anchor habitat reaches in the Salmon River watershed. A portion of Still Creek in the Zigzag River watershed and portions of Lost Creek and Clear Fork in the upper Sandy River watershed make up the remaining anchor habitat reaches for coho. The City considered the anchor habitat reaches for coho salmon when choosing offsite habitat conservation measures (see Chapter 7).

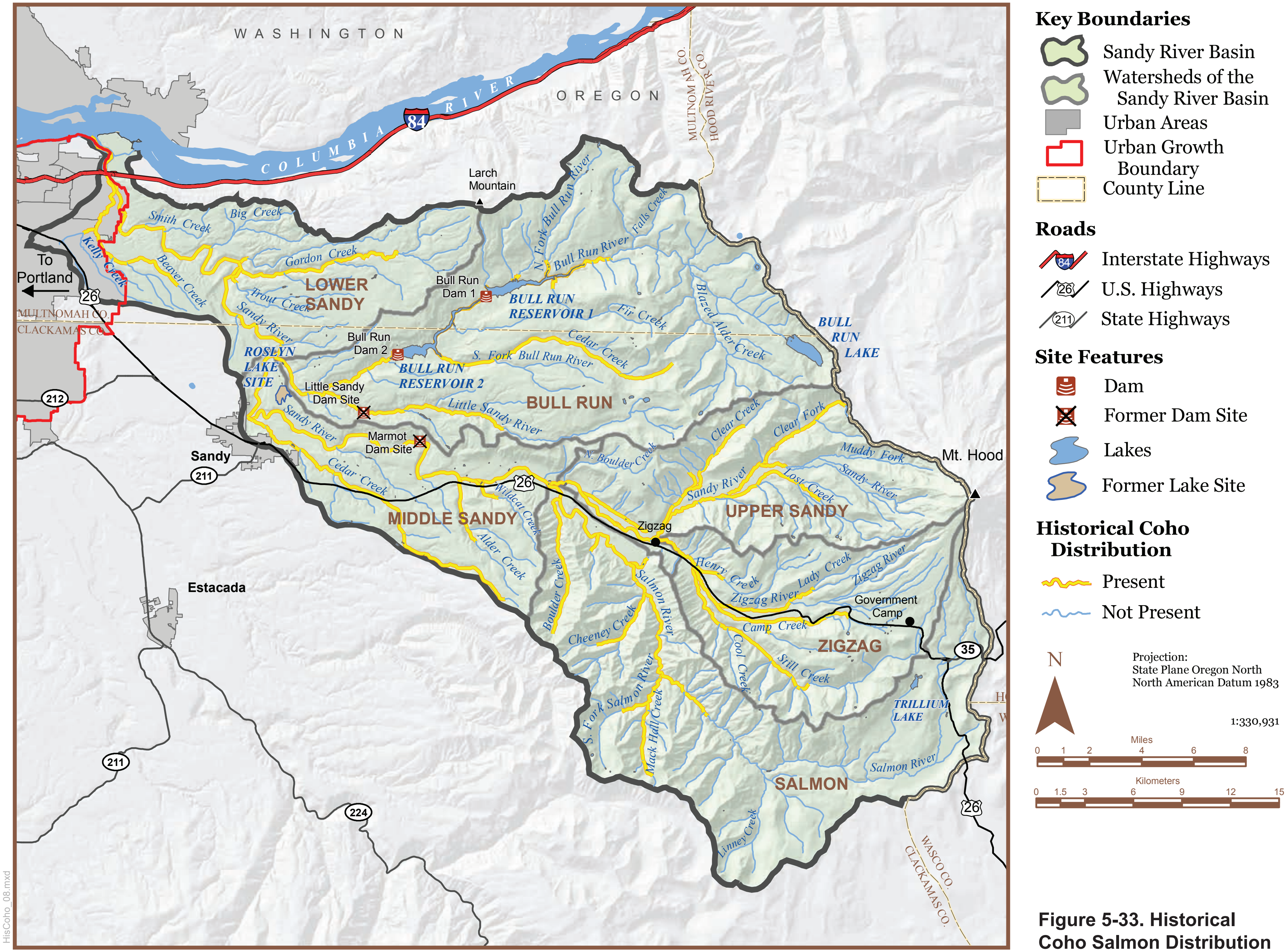


Figure 5-33. Historical Coho Salmon Distribution

Abundance

On an ESU-wide scale, over 90 percent of the Lower Columbia River historical coho populations appear to be either extirpated or nearly extirpated (Iwamoto et al. 2003). The natural origin Sandy and Clackamas river coho populations are believed to be depressed but stable. There are conflicting opinions concerning whether the current naturally produced coho in the Sandy River Basin are the same stock as the historical late run coho indigenous to the Basin. It is possible the historical wild stock of Sandy coho salmon has been extirpated (ODFW 1990; Weitkamp et al. 1995).

Hatchery supplementation of coho salmon above Marmot Dam occurred from the 1960s until the 1990s (ODFW 2001). The extent of historical straying of hatchery-produced coho salmon into the upper Basin spawning tributaries is largely unknown, but is believed to occur at very low levels (ODFW 1997). In November 1998, a trapping facility was created in the Marmot Dam fish ladder which resulted in sorting all fish prior to passage upstream. Record keeping began in 1999, including a complete breakdown of wild and hatchery fish. In run years 1999–2003, a total of 8 hatchery coho and 3,477 unmarked coho were recovered in the trap (0.2 percent hatchery stray rate).

Average recent population abundance of natural-origin spawners is best indicated by adult counts at Marmot Dam. In run years 1980–1989, escapement averaged 1,068 adults. However, sport fishery impacts above Marmot Dam were not recorded until 1988, when stream code segments were derived to differentiate between sport catch in the upper and lower portions of the Basin. In run years 1988 and 1989, only 15 fish were harvested in the upper Basin upstream of Marmot Dam.

Three estimates of coho salmon abundance in the upper Basin are graphically displayed in Figure 5-34. The highest, lowest, and average run sizes between 1990 and 1999 at Marmot Dam were 1,491, 116, and 585 adult fish, respectively. These estimates included hatchery and wild fish. By 1997, most direct harvest of wild coho salmon in the upper Sandy River Basin had been curtailed due to the implementation of marked selective fisheries for adipose-fin-clipped hatchery coho. As a result, sport fishery impacts to natural-origin spawners upstream of Marmot Dam in 1998 and 1999 were probably minimal. In run years 2000–2003, escapement averaged 831 adults and angling upstream of Marmot Dam was not allowed.

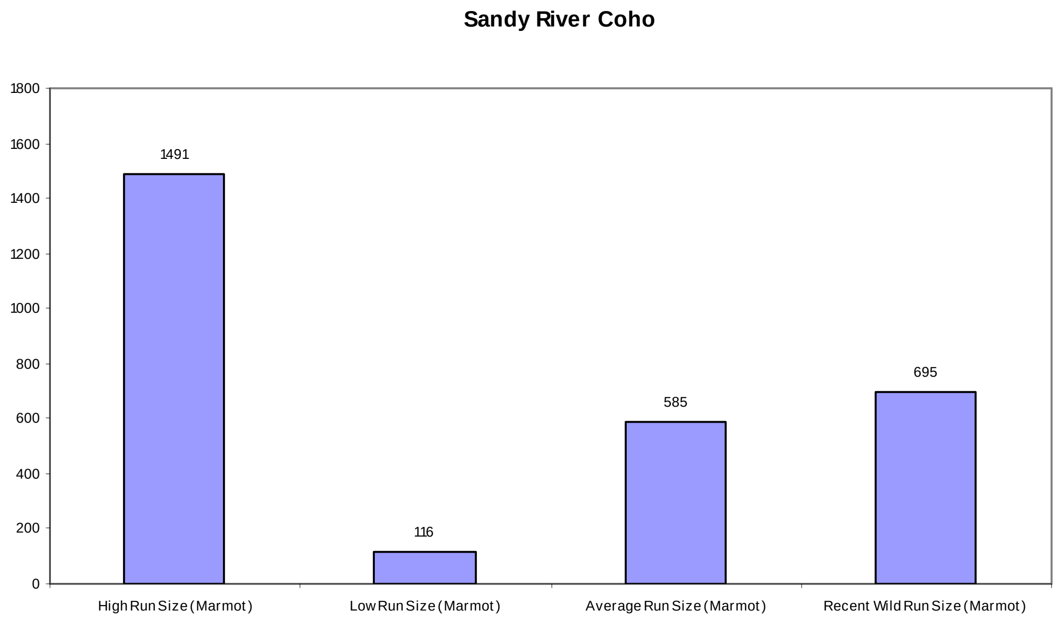


Figure 5-34. Estimates of Coho Salmon Abundance Upstream of Marmot Dam

Source: ODFW 2003a.

There are no Fisheries Management and Evaluation Plan or Critical/Viable abundance threshold criteria developed for coho salmon in the Lower Columbia River ESU. ODFW set an adult coho escapement goal at Marmot Dam of 1,100 adults (ODFW 1997). This goal was only achieved once in the 1990–1999 period. The objective in the Oregon Administrative Rules (OAR 635-500-3450) is to achieve a minimum five-year average spawning escapement of 1,100 wild coho salmon.

EDT estimates of adult coho production were also based on the same geographic point of reference used for the empirical abundance estimates in ODFW (2003a) and on the same harvest rate. EDT estimates of adult abundance included all spawning areas upstream of Marmot Dam. The estimates did not include production occurring from mainstem Sandy River reaches downstream of Marmot Dam or lower river tributaries.

EDT estimated current habitat conditions would support adult coho production above Marmot Dam at approximately 550 adult fish. The EDT estimate assumed a 50 percent harvest rate that reflects the average exploitation rate observed in the 1990s. EDT estimated that under fully restored freshwater conditions, coho adult returns above Marmot would be about 2,400 fish.

Marmot Dam counts of adult coho salmon have been quite variable. Table 5-4 shows the averages in multiple-year increments since 1990. The difference in adult counts during these time frames illustrates that adult run size back to the Basin is highly variable and is primarily the result of out-of-basin factors, such as ocean conditions. Regardless, the EDT estimates of adult coho production appear to fit the Marmot Dam count data quite well.

Table 5-4. Average Adult Escapement, 1990–2003

Time Period	Average Adult Escapement
1990–1995	691
1996–1999	180
2000–2003	831

Source: ODFW 2003a

Hatchery Production and Plantings

Current. Current coho salmon hatchery production in the Sandy River Basin takes place at the Sandy Hatchery located on Cedar Creek, a tributary to the lower Sandy River below the Marmot Dam site. The stock used is native to the Sandy River, and the annual release is 700,000 smolts (Bourne, pers. comm., 2004). To reduce the incidence of straying, all coho smolts released into the Sandy River are reared and acclimated at Cedar Creek.

Historical. Coho salmon hatchery supplementation began in the Sandy River Basin in 1898 at the Oregon Fish Commission Hatchery located on Boulder Creek in the Salmon River watershed (ODFW 1997). In 1912, a new hatchery was constructed in the lower Basin and began operation concurrently with the completion and operation of Marmot Dam. The Marmot Dam diversion canal was unscreened from 1912 to 1951, and managers believed a majority of fish released upstream of the diversion would likely have been diverted into Roslyn Lake and the Bull Run Hydroelectric Project. Coho salmon were intermittently intercepted during the 1912–1951 period when hatchery racks were placed in the river to satisfy various in- and out-of-basin egg-take needs. Records show coho salmon eggs collected at this facility declined from 500,000 in 1939 to less than 15,000 in 1945 (ODFW 1997). Beginning in 1950, smolt releases were directed to Cedar Creek and the Sandy Hatchery that began operations in 1951 (ODFW 1997). Preliminary annual releases of coho from the Sandy Hatchery were 250,000 smolts, but this amount increased steadily to one million smolts by the 1990s (PGE 2002; ODFW 1997).

Harvest in the Basin

Current. Harvest in the Sandy River Basin is now restricted to adipose-fin-clipped coho salmon of hatchery origin. Angling and harvest have been restricted to the lower Basin downstream of Marmot Dam since 1999, when a salmon and steelhead sanctuary was designated in the upper Basin. Recent harvest rates of natural-origin Sandy River coho salmon have declined to less than 20 percent for run years 1998–2001 (Iwamoto et al. 2003).

Sandy Hatchery coho make up a significant portion of recreational and commercial freshwater and ocean harvest in the Northwest. In 2001, the preliminary return of hatchery coho to the Columbia River Basin was 1,076,000 adults and 19,400 jacks (Watts 2003). In the 2001 Buoy 10 recreational fishery, anglers made 125,800 trips and caught 132,000 fin-clipped coho (Watts 2003). The 2001 Lower Columbia River recreational catch of hatchery coho upstream of Buoy 10 was 3,068 adults and 381 jacks, and an additional 425 unmarked coho were released (Watts 2003). The 2001 ocean recreational coho catch for the Columbia River

Catch Area was 39,200; the 2001 ocean coho troll harvest for the same area was 9,300 (Schindler 2003).

Historical. Hatchery production of coho salmon in the Lower Columbia River and tributaries increased in the late 1960s. Annual returns since the mass production of coho smolts in the 1960s have averaged nearly 500,000 coho annually (Watts 2003). From the late 1960s through the early 1990s, harvest rates sometimes reaching 90 to 100 percent of both hatchery and natural origin coho led to precipitous declines in wild coho populations in the Lower Columbia River and its tributaries (Iwamoto et al. 2003; Watts 2003).

Historical harvest of Sandy River natural origin coho was estimated to be in the range of 60 to 100 percent from 1977 through 1993 (Iwamoto et al. 2003). In the 12-year period from 1981 to 1992, sport anglers caught an estimated average of 1,263 coho annually in the Sandy River, for an interception rate of only 2.9 percent of all coho caught in recreational and commercial fisheries or that returned to the Sandy Hatchery (ODFW 1997). Table 5-5 shows the counts of recreational and commercial ocean fish harvests of Sandy Hatchery fish outside of the basin.

Table 5-5. Harvest of Sandy River Coho Outside of the Basin, 1981–1992

	Available Hatchery Fish	
Harvest Type	Count	Percentage
Recreational sport	10,695	24.3
Commercial ocean	19,170	43.5

Source: ODFW 1997.

Low levels of coho salmon escapement on an ESU-wide scale from 1993–1999 drastically reduced harvest opportunities in both ocean and freshwater fisheries. Coho ocean fisheries from Washington to California were closed in 1994 and were very limited in 1995 through 1999. Additionally, freshwater fisheries in 1993–1999 were limited as well. In 1994 and 1996, emergency closures were enacted on the Sandy River freshwater fishery that prohibited angling for coho salmon. Substantial reductions in commercial gill net fisheries in the Columbia River were also enacted, and current harvest is restricted to adipose-fin-clipped coho salmon.

Reasons for Listing/Threats to Survival

Three sources of information are available to help explain the reasons coho salmon have decreased in abundance in the Sandy River Basin: NMFS documents, ODFW reports, and EDT model results, as discussed below.

National Marine Fisheries Service. Four factors contributed to the decline of West Coast coho salmon populations (NMFS 1995): harvest, habitat degradation, artificial propagation, and adverse environmental conditions (primarily drought and poor ocean productivity). NMFS (1995) identified the following factors contributing to the decline of coho salmon in the Lower Columbia River ESU:

- habitat degradation from logging
- agricultural activities
- urbanization
- stream channelization
- dams
- water withdrawals and unscreened diversions
- competition and interbreeding with hatchery fish
- overharvest
- adverse ocean conditions over the last two decades
- inadequate regulatory mechanisms

Harvest has historically been very high on the Lower Columbia River coho salmon in both ocean and freshwater fisheries. Recent substantial reductions in natural origin coho harvest have not led to significant increases in coho salmon returns to the Lower Columbia River ESU. Habitat degradation has occurred as a result of logging, agricultural activities, urbanization, stream channelization, dam construction and operation, wetland reduction, and water withdrawals. Artificial propagation of coho salmon became very popular in the 1960s and continues today in the ESU. Adverse ocean conditions during the last two decades have led to poor marine survival and further depressed adult coho salmon returns to the ESU.

Oregon Department of Fish and Wildlife. The Sandy River Subbasin Salmon and Steelhead Production Plan (ODFW 1990) and Sandy Basin Management Plan (ODFW 1997) identified the following factors that reduced the production potential of native coho salmon in the Sandy River Basin:

- In the lower Basin tributaries (below the Marmot Dam site), coho production was limited by low summer flow, sedimentation, and high temperatures.
- Upper Basin coho production has been limited by constraints such as blocked passage, low pool-to-riffle ratio, lack of stream cover, channelization and loss of habitat diversity, lack of spawning gravel, and sedimentation in some of the upper tributaries. (Note: several of these passage barriers have since been corrected).
- The Basin has been stocked intensively with early-run coho for many years, probably to the detriment of the late-run native coho. Competition between naturally spawned and planted early-run juveniles may have affected the survival or growth of late-run juveniles.

The Bull Run water supply dams have also blocked passage to approximately 24 miles of historical coho spawning habitat in the upper Bull Run River watershed. Of this total spawning habitat, approximately nine miles have been inundated by the reservoirs, making it no longer suitable for coho spawning.

EDT Modeling. For the Sandy River Basin, EDT model estimated the primary limiting factors for coho to be the following:

- <u>Habitat diversity</u>. The primary losses of habitat diversity affecting coho in the Bull Run River watershed were assumed to be due to dam construction. The lower Sandy and Zigzag rivers have losses due to artificial confinement of the stream channels, loss of riparian function, and reductions in large woody debris.
- <u>Key habitat quantity</u>. Key habitat has decreased due to simplification of the stream channel, loss of large woody debris, increased confinement, and changes in low flow.

- Channel stability. The stream channel has become less stable in most of the Basin. Instability is caused by a loss in large woody debris, riparian function, and high streamflows.
- Obstruction. The dams in the Bull Run River and the weir in Cedar Creek have reduced coho salmon productivity.

Other minor limiting factors include changes in low flow (Bull Run and lower Sandy rivers), food (carcasses), sediment, and competition with hatchery fish released into the lower Sandy River (see Figure 5-35).

	Limiting Factors															
Geographic Area	Channel Stability	Chemicals	Competition (hatch)	Competition (other species)	Flow	Food	Habitat diversity	Hasassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Bull Run River	●				●	•	⬤		⬤				●	•		●
Columbia River			•				•				•	●				●
Lower Sandy River	●		•		●	•	⬤	•					●			●
Middle Sandy River	•				•	•	●		⬤				●			●
Upper Sandy River	•				•	•	●						•			•
Salmon River	•				•	•	●									●
Zigzag River	•				•		⬤						●			●

Figure 5-35. Limiting Factors for Coho Salmon in the Sandy River Basin[a,b]

Percentage change from historical conditions	Worse
Less than 1%	
Between 1 and 5%	•
Between 5 and 20%	●
More than 20%	⬤

Source: EDT model run 10/20/06.

[a]Appendix D provides definitions of the limiting factors (level 3 survival factors) and the habitat attributes (level 2 environmental attributes) and a matrix showing the relationship between them.

[b]The habitat attributes are also used in Chapter 8 and Appendix E to define the reference condition for the habitat benefits that arise from the City's HCP measures.

Coho in the Bull Run Watershed

Distribution

Coho salmon have access to about 7.5 stream miles of stream habitat in the Bull Run River watershed. Of this total, approximately 5.8 miles occur in the lower Bull Run River downstream of the Headworks, with an additional 1.7 miles in the Little Sandy River. Figure 5-36 shows the estimated periods of occurrence for coho salmon in the lower Bull Run River.

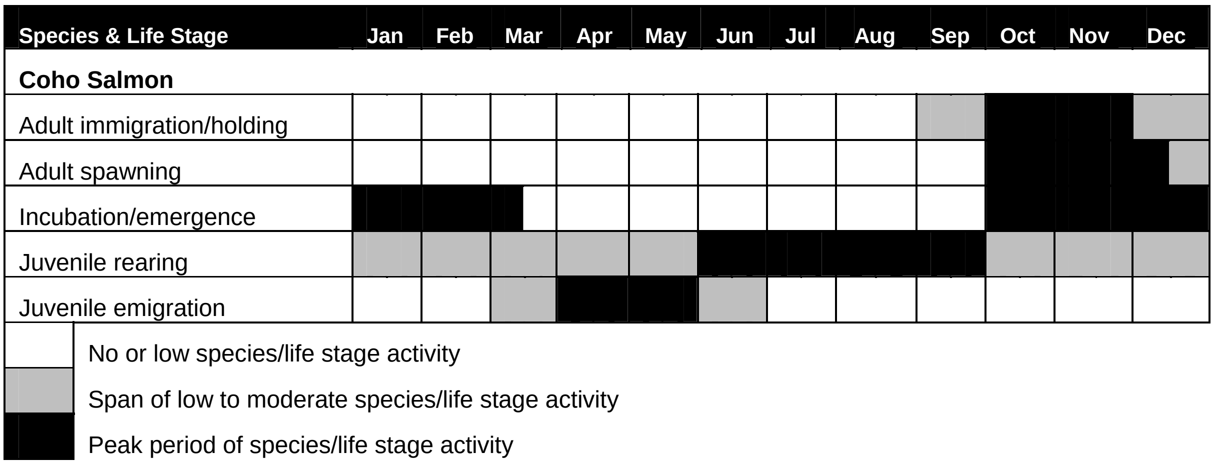


Figure 5-36. Estimated Periods of Occurrence for Coho in the Lower Bull Run River

Source: Sandy River Basin Agreement Technical Team 2002.

Table 5-6 summarizes the river segments and historical distribution of coho in the Bull Run watershed. Figure 5-33 on page 5-64 shows historical coho distribution throughout the Sandy River Basin.

Table 5-6. Historical Distribution of Coho in the Bull Run Watershed

River Segment	River Miles
Lower Bull Run River	
Bull Run River (mouth to Dam 2 spillway weir)	5.8
Walker Creek	0.15
Little Sandy River (mouth to Little Sandy Dam site)	1.7
Little Sandy River (Little Sandy Dam site to middle waterfalls)	5.6
Upper Bull Run River	
Bull Run River (Dam 2 spillway weir up through reservoirs)	9.2
Bull Run River (free-flowing river to waterfall at RM 16.3)	1.3
South Fork Bull Run River	2.7
Cedar Creek (tributary to South Fork Bull Run River)	8.1

Source: USFS, 1999

Photo courtesy of Bonneville Power Administration.

Fish access is blocked by dams and culverts in the Bull Run watershed. Fish passage is blocked at RM 5.8 on the lower Bull Run River and has been blocked at RM 1.7 of the Little Sandy River. Other tributaries to the lower Bull Run River have limited productivity potential for anadromous fish because of steep gradients or natural waterfalls (City of Portland 2002). Additionally, a culvert barrier at the mouth of Walker Creek blocks access to about 800 feet of this Bull Run tributary (City of Portland 2002).

A few adult coho have been sighted during weekly adult fish spawning counts in the mainstem Bull Run up to approximately a mile above the Little Sandy River confluence. However, juvenile coho have seldom been observed in the lower Bull Run River.

Abundance

Under current habitat conditions and access limitations, the EDT model estimates that the habitat in the lower Bull Run and Little Sandy rivers could produce 1 and 382 adult coho salmon, respectively. The low abundance estimates reflect habitat conditions in these two rivers. The rivers are highly confined, relatively steep, and dominated by bedrock and large cobble gravel substrates, conditions not favored by coho salmon. Historical juvenile abundance was estimated through modeling at fewer than 10,000 fish.

These EDT estimates of current coho production are supported by recent observations for the lower Bull Run River. For surveys completed in the late 1990s and recently in 2005, fewer than five adult coho per year have been seen.

Habitat Conditions

The habitat conditions described for Chinook and steelhead also have similar effects on coho salmon for the lower Bull Run River. The City has been studying the aquatic habitat of the lower Bull Run River since the mid-1990s and those studies have focused on current habitat conditions and use by anadromous species. The various studies (Clearwater BioStudies 1997;

R2 Resources Consultants 1998a, b; Beak 1999, 2000a) indicated that the following key environmental factors may have affected the abundance and productivity of coho in the lower Bull Run River:

- Dams and culverts block access to potential upstream spawning habitat.
- High water temperatures during summer may affect coho juvenile growth and survival.
- High water temperatures may affect spawning in early October.
- Sustained summer low flows may reduce the amount of instream habitat suitable for use by juvenile coho.
- Gravel in the lower river suitable for spawning and construction of redds is lacking or absent.
- Rapid, short-term flow fluctuations during spring may cause stranding or displacement of coho fry.

Limiting Factors

The City used the EDT model to determine the limiting factors affecting coho salmon production throughout the historical range for the fish in the Bull Run River watershed. However, coho cannot travel upstream of reach Bull Run 4 and Little Sandy 1 due to the dams. Reach-specific results for coho in the Bull Run River watershed are summarized in Figure 5-37.

	Life Stage Most Affected													Limiting Factor															
	Spawning	Egg incubation	Fry colonization	0-age migrant	0-age active rearing	0,1-age inactive	1-age migrant	1-age active rearing	2+-age active rearing	2+-age migrant	2+-age transient rearing	Prespawning migrant	Prespawning holding	Channel stability	Chemicals	Competition (w/hatch)	Competition (other species)	Flow	Food	Habitat diversity	Harassment/poaching	Obstructions	Oxygen	Pathogens	Predation	Sediment load	Temperature	Withdrawals	Key habitat quantity
Bull Run Bear 1		2	1			3								●			•	⬤	⬤	⬤									◯
Bull Run Camp 1		3	1		2									●		•	•	●	⬤	⬤							•		⚪
Bull Run Dam 1				3			2					1										⚫							
Bull Run Dam 2				3			2					1										⚫							
Bull Run Spillway Weir			3				2					1										⚫							
Bull Run 1		1	3		2									⚫				•	●	•						•	⬤		⬤
Bull Run 2		1			2	3								⚫				⬤	•	●							⚫		•
Bull Run 3	3	1			2									⚫				⬤	●	◦							⚫		⚪
Bull Run 4		3			1	2								●		•		●	●	⚫							⬤		○
Bull Run 5			3			2						1										⚫							
Bull Run 6					2	1	3							•		•		•	●	⚫						⬤	•		⚪
Bull Run 6a			3		1	2								•		•	•	•	●	⚫							•		⚪
Bull Run 7			1		2														●										
Cougar 1			2		3	1								•		•		●	●	⬤									⚪
Cougar 2						1	3	2						•				•	•	•									
Deer 1		3	1										2	●			•	⬤	⬤	⬤									◯
Deer 2	1	2	3																										⚫
Fir 1			1		2	3													•										
Little Sandy 1		3	2		1									•				•	•	⬤									⬤
Little Sandy 2																			•										
N.F. Bull Run 1		3	1		2									●		•	•	●	⬤	⚫									⚪
N.F. Bull Run 2	3	2	1											•				●	●	⬤									◯
SF Bull Run 1			1	3	2									●		•	•	⬤	⬤	⚫						⬤			⚪
S.F. Bull Run 2			2		1														●										

Figure 5-37. Limiting Factors for Coho Salmon in the Bull Run River Watershed[a,b]

Percentage change from historical conditions	Worse	Better
Less than 0.2 %		
Between 1.0 and 0.2%	•	◦
Between 5 and 1%	●	○
Between 25 and 5%	⬤	◯
More than 25%	⚫	⚪

Source: EDT model run 10/20/05

[a]Appendix D provides definitions of the limiting factors (level 3 survival factors) and the habitat attributes (level 2 environmental attributes) and a matrix showing the relationship between them.

[a]Bull Run reaches 5 and higher are the reaches at or above the Dam 2 diversion pool and include the reservoirs. The limiting factors in this figure for Bull Run reaches 5 and above are primarily the results of inundation of the Bull Run River by the reservoirs.

Ten of the 16 limiting factors affect coho survival among the reaches in the watershed. Of these, channel stability, flow, food, habitat diversity, obstructions, sediment load, temperature, and key habitat quantity have a high effect in depressing productivity in all but five (Bull Run 7, Cougar 2, Fir 1, Little Sandy 2, and South Fork Bull Run 2) of the 24 reaches analyzed by EDT for coho salmon.

Flow and Steelhead Habitat Preferences

Because City operations in the Bull Run divert flow from the watershed, and that effect is a focus of this HCP, additional information on the relationship between streamflow and fish habitat preferences is provided below for steelhead.

Spawning Flow-Habitat Relationships. Figure 5-38 shows the relationship between total usable habitat and flow for spawning salmonids in the lower Bull Run River between Dam 2 (approximately RM 5.8) and PGE's powerhouse at RM 1.5. These relationships are applicable to Chinook salmon, steelhead, and coho salmon.

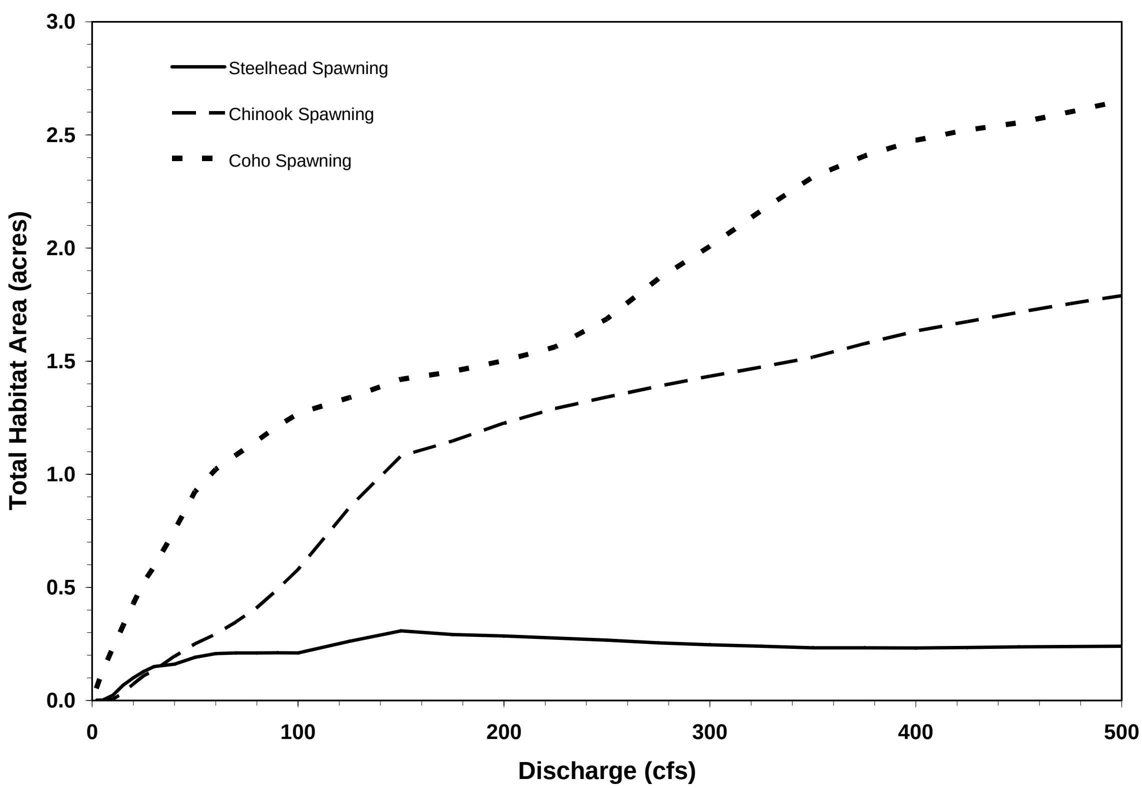


Figure 5-38. Relationship Between Flows in the Lower Bull Run River and Available Spawning Habitat for Chinook, Coho Salmon, and Steelhead

Source: R2 Resource Consultants 1998a.

Within the flow range modeled (0–500 cfs), the relationship for coho indicates that spawning habitat increases with increasing discharge.

Juvenile Rearing Flow-Habitat Relationships. Figure 5-39 shows the relationship between total usable habitat and flow for rearing juvenile coho in the lower Bull Run River.

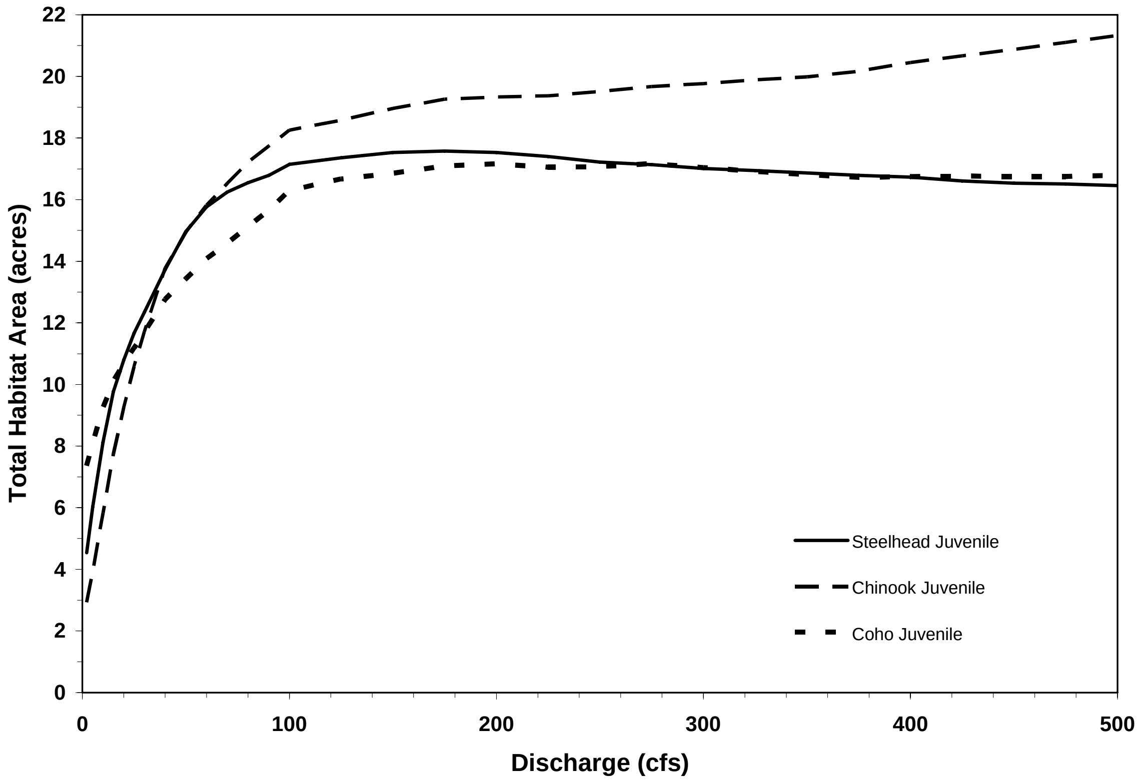


Figure 5-39. Relationship between Total Usable Habitat and Flow for Rearing Juvenile Coho in the Lower Bull Run River

Source: R2 Resource Consultants 1998a.

Results of PHABSIM modeling indicate that habitat conditions for juvenile coho increase at a rapid rate between 0 and 100 cfs, with most of the rapid increase occurring between 0 and 20 cfs (R2 Resource Consultants 1998a). Habitat conditions for juvenile salmonids become near constant at flows above 100 cfs.

The results of the PHABSIM modeling are expressed as weighted usable area (WUA), an index of available instream habitat at various increments of flow. R2 Resources Consultants estimated WUA for a number of flows in various reaches of the lower Bull Run River by (1998a) using the PHABSIM model. The WUA estimates for each species are shown in Chapter 8, Effects of the HCP.

5.4.2 The Other Covered Fish Species

Chum Salmon

Approximately 90 percent of the historical population in the Columbia River chum ESU is extirpated or nearly so (Good et al. 2005). Recently, the abundance of natural spawners has increased substantially at several locations in the ESU. The cause of the increase is unknown. However, long- and short-term productivity trends for the ESU populations are at or below replacement levels.

In Oregon, chum salmon are found in the Columbia River and along the coast as far south as the Coquille River (Kostow 1995). Historically, annual Columbia River harvest of chum reached 500,000 fish (ODFW 2005). Today, chum salmon populations are extinct in the Oregon tributaries to the Columbia, including the Sandy River. It is believed that the few fish observed in Oregon are strays from runs that return to the Washington tributaries of the lower Columbia River. The populations that remain in Multnomah County are low in abundance and have limited distribution.

Life History and Diversity

Salo (1991) reported that chum salmon migrate upstream during October and November, and spawning can continue into December (Cooney and Jacobs 1994). In general, upstream chum migration can occur quickly, with transport rates of 30 miles per day. The length of embryo incubation is influenced primarily by water temperature. For example, eggs at 15 °C hatch approximately 100 days before eggs incubated at 4 °C. Health of the emergent chum fry, as with the other salmonid fish species, also depends on dissolved oxygen, gravel composition, spawner density, stream discharge, and genetic characteristics (Salo 1991).

Juvenile chum salmon rear in fresh water for a period of a few days to several weeks before migrating downstream to saltwater (Grette and Salo 1986). In Washington, downstream chum salmon migration occurs from late January to May (Johnson et al. 1997). Chum outmigration is associated with increasing day length and warming of estuarine waters. Juvenile chum have longer rearing times in estuaries than most salmon, and estuarine survival appears to play a major role in determining subsequent adult return to fresh water (Johnson et al. 1997). Simenstad et al. (1982) found chum salmon generally moved offshore at a size of between 50 and 160 millimeters (mm) (2 to 6 inches) fork length. Chum salmon mature anywhere between two and six years of age (Salo 1991).

Juvenile chum salmon migrate from fresh water shortly after emergence and rear primarily in estuarine waters for a period of up to several months. Fry may remain near the mouth of their natal river after entering the estuary or may disperse rapidly throughout the estuarine system into tidal creeks and sloughs (Johnson et al. 1997).

Chum salmon are reported to spawn in shallow, slow-velocity streams and side channels (Johnson et. al. 1997). Preferred spawning areas include groundwater-fed streams or at the head of riffles (Grette and Salo 1986). Groundwater upwelling is important to redd site selection (Johnson et al. 1997).

Distribution

There is no information on the current or historical distribution of chum salmon in the Sandy River Basin. The few fish that have been observed are believed to be strays from the Washington streams in the Columbia River ESU.

The City assumes that, historically, chum salmon may have been distributed in the lower part of the Sandy River Basin, and perhaps the lower end of Beaver Creek. Chum frequently spawn in tidal areas and show limited ability to surmount migration obstacles.

Abundance and Productivity

No data were available on the Sandy River chum salmon population. The Sandy population is now extinct (ODFW 2005).

Hatchery Production and Plantings

There are three chum salmon artificial production programs considered to be part of the Lower Columbia River ESU (NMFS 2005). They are conservation programs that have been designed to support natural production. The Washougal Hatchery program provides fish for reintroduction into the recently restored habitat in Duncan Creek, Washington. The other two hatchery programs are designed to augment natural production in the Grays River and the Chinook River in Washington. These two programs are relatively new, with the first hatchery chum returning in 2002.

Harvest in the Basin

No data exist on the current or historical harvest of chum salmon in the Sandy River Basin. Almost all of the harvest probably occurred outside of the Sandy River Basin because chum salmon arrive on the spawning grounds in an advanced state of sexual development. Chum salmon are not considered a sport fish, and they are not sought after by anglers.

Reasons for Decline/Threats to Survival

Johnson et al. (1997) listed variations in the freshwater and ocean environment, and artificial propagation as contributing to fluctuations in chum population abundance. Kostow (1995) reported chum salmon spawning habitat in Oregon has been affected by gravel mining operations, channelization, and siltation associated with road construction and logging. Kostow also notes that losses and degradation of estuarine habitats have likely had a large affect on chum salmon populations.

Eulachon

Eulachon (smelt) are endemic to the eastern Pacific Ocean ranging from northern California to southwest Alaska and into the southeastern Bering Sea. Eulachon occur only on the coast of northwestern North America, from northern California to southwestern Alaska. In the portion of the species' range that lies south of the U.S.-Canada border, most eulachon production originates in the Columbia River Basin.

In 1999, NMFS received a petition to list the Columbia River populations of eulachon as an endangered or threatened species and to designate critical habitat under the ESA. NMFS determined that the petition did not present enough substantial evidence to warrant the listing (64 FR 66601). In 2007, NMFS received a petition from the Cowlitz Indian Tribe to list southern eulachon (populations in Washington, Oregon, and California) as a threatened or endangered species under the ESA. After reviewing the information contained in the petition and other information, NMFS determined that the petition presented substantial scientific and commercial information indicating that the petitioned action may be warranted. NMFS commenced a review of the status of the species and will make a determination as to whether the petition action is warranted (73 FR 13185). The current status of eulachon is as a candidate species.

Life History and Diversity

Within the Columbia River Basin, the major and most consistent spawning runs occur in the mainstem of the Columbia River (from just upstream of the estuary, river mile (RM) 25 to immediately downstream of Bonneville Dam at RM 146). Periodic spawning occurs in the Grays, Skamokawa, Elochoman, Kalama, Lewis, Cowlitz, and Sandy rivers (Emmett *et al*. 1991, Musick *et al*. 2000). In the Columbia River and its tributaries, spawning usually begins in January or February (Beacham *et al.* 2005).

Eulachon are anadromous fish that spawn in the lower reaches of rivers in early spring. They typically spend three to five years in saltwater before returning to freshwater to spawn from late winter through mid-spring. Spawning occurs over sand or coarse gravel substrates, eggs are fertilized in the water column, sink, and adhere to the river bottom. Most adults die after spawning, and eggs hatch in 20 to 40 days. The larvae are carried downstream and are dispersed by estuarine and ocean currents shortly after hatching. Runs tend to be erratic, appearing in some years but not others, and appearing only rarely in some river systems (Hinrichsen 1998).

Eulachon are important in the food web as a prey species (Alaska Department of Fish and Game 1994). Newly hatched and juvenile eulachon are food for a variety of larger marine fish such as salmon and for marine mammals including seals, sea lions, and beluga whales. Spawned-out eulachon are eaten by gulls, eagles, bears, and sturgeon.

Although eulachon abundance exhibits considerable year-to-year variability, nearly all spawning runs from California to Alaska have declined in the past 20 years (Hay and McCarter 2000). From 1938 to 1992, the median commercial catch of eulachon in the Columbia River was 1.9 million pounds. From 1993 to 2006, the median catch had declined to approximately 43,000 pounds.

Distribution

There is no information on the current or historical distribution of eulachon in the Sandy River Basin. Spawning runs typically occurred within the first few miles of the Sandy River, perhaps up to the lower end of Beaver Creek.

Abundance and Productivity

No data were available on the Sandy River eulachon population.

Harvest in the Basin

No data exist on the current or historical harvest of eulachon in the Sandy River Basin. A tribal and sport fishery occurs when smelt runs occur, and the Oregon Department of Fish and Wildlife allows a sport (limit of 25 pounds per day) and commercial harvest of eulachon below the I-84 bridge in Troutdale. The commercial harvest is exported to places like Sea World in San Diego to feed the marine mammals.

Reasons for Decline/Threats to Survival

Eulachon spawning runs have declined in the past 20 years, especially since the mid-1990s (Hay and McCarter 2000). The cause of these declines remains uncertain. Eulachon are caught as bycatch during shrimp fishing, but in most areas the total bycatch is small (Beacham et al. 2005). Predation by pinnipeds and sturgeon may be substantial, and other risk factors could include global climate change, blocked passage, and deterioration of marine and freshwater conditions.

5.4.3. Other Fish Species Addressed in the HCP

In addition to the covered species, five other fish species will benefit from this HCP: rainbow trout, cutthroat trout, Pacific lamprey, western brook lamprey, and river lamprey. The following subsections provide information on each species' life history and diversity, distribution, abundance and productivity, hatchery production and plantings, its harvest in the Sandy River Basin, and reasons for its decline or threats to its survival. The information available for each species varies. EDT modeling data and results are not provided for these species.

Rainbow Trout

Rainbow trout is the same species as winter steelhead. The City assumes that habitat preferences for rainbow in the lower Bull Run watershed and the Sandy River Basin are the same as for steelhead. Rainbow trout are also found in Bull Run Reservoir 1, and their habitat preferences should be similar to those described below for cutthroat trout.

Cutthroat Trout

Life History and Diversity

Coastal cutthroat trout (*O. clarki clarki*) are native to the Sandy River Basin and exhibit a wide range of life history characteristics, depending on their location in the watershed. Sandy River Basin coastal cutthroat trout belong to the Southwest Washington/Columbia River distinct population segment, which contains all populations from Grays Harbor (Washington) in the north, south to the Columbia River, and east to the Klickitat River (Washington) and Fifteen Mile Creek (Oregon) (Johnson et al. 1999; PGE 2002).

There are four documented life-history expressions: resident, fluvial, adfluvial, and anadromous. Resident natural cutthroat trout (nonmigratory) exist in small headwater streams, commonly above natural passage barriers to anadromous salmonids, and they rarely venture far from where they hatch. Fluvial cutthroat trout reside in mainstems of large rivers and migrate into small tributaries for spawning and occasional protection from high winter flows. Adfluvial cutthroat trout reside in lakes and migrate to tributaries to spawn. Anadromous (sea-run) cutthroat trout migrate to estuaries and the ocean as juveniles usually for less than one year, before returning to fresh water to spawn.

Reentry of anadromous fish into large freshwater river systems in Washington and Oregon for spawning migrations usually begins as early as June, continuing through October, and peaking in late September and October (Johnson et al. 1999). Estimated periods of occurrence of anadromous cutthroat trout life stages in the lower portion of the Sandy River Basin (below the Marmot Dam site) are shown in Figure 5-40. Anadromous cutthroat trout are assumed not to be present in the upper portion of the Sandy River Basin (above the Marmot Dam site) because no large cutthroat have been counted passing Marmot Dam since 1977, when counting facilities became available (Hooten 1997).

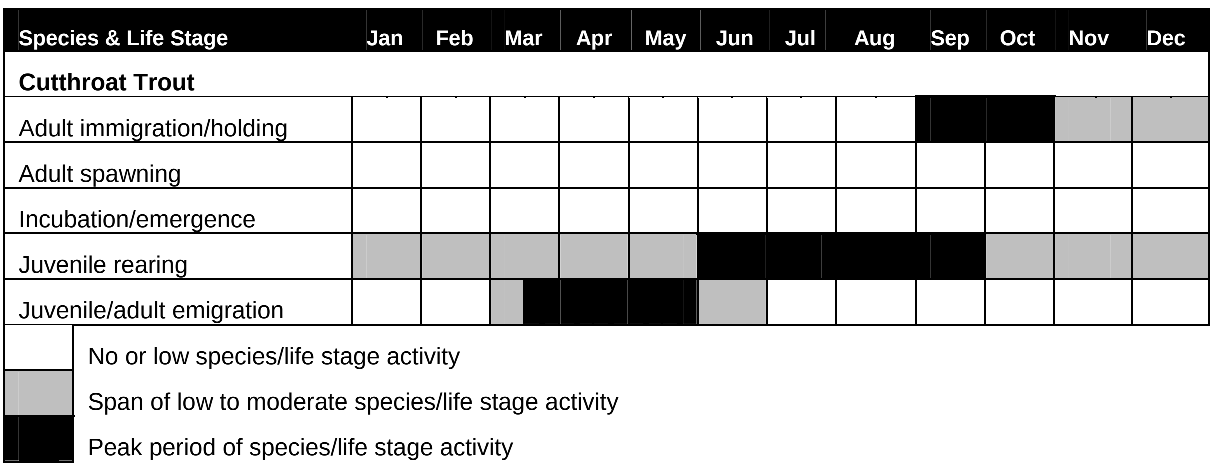


Figure 5-40. Estimated Periods of Occurrence for Cutthroat in the Lower Sandy River Basin Below Marmot Dam

Source: Sandy River Basin Agreement Technical Team 2002.

Generally, coastal cutthroat trout exhibit a wide range of variation in age and size at sexual maturity. Resident, fluvial, and adfluvial coastal cutthroat trout typically mature between two and three years, while anadromous life forms rarely spawn before age four (Johnson et al. 1999).

Coastal cutthroat trout spawning periods vary from late winter to summer, depending on life-history type. Female cutthroat trout commonly lay between 200 to 4,000 eggs in gravel redds (ODFW 1997). Eggs typically hatch within four to eight weeks, depending on water temperature, and fry spend one to two weeks in the gravel before emerging. Resident cutthroat trout remain in their natal streams as juveniles and adults. Fluvial and adfluvial cutthroat trout remain in their natal streams for up to a year before migrating to other streams, rivers, or lakes. Juvenile sea-run cutthroat trout usually migrate to lower reaches of streams in their first year. These smolts then migrate downstream to estuaries as early as one year old, but more commonly when they are between two and four years old (Johnson et al. 1999).

Distribution

Current. Resident cutthroat trout are widely distributed in the Sandy River Basin, but anadromous migratory cutthroat trout behavior and distribution in the Sandy River Basin are poorly documented and understood. Cutthroat trout generally prefer small tributary streams for spawning and rearing (PGE 2002). Resident cutthroat trout populations likely occur in most tributary streams of both the lower and upper portions of the Basin (ODFW 1997). Based on recent counts at Marmot Dam, it is assumed that no anadromous cutthroat trout currently migrate into the upper Basin. Isolated populations of resident cutthroat trout above natural and anthropogenic passage barriers represent an important genetic resource to individual and basin-wide populations. A genetically distinct population of adfluvial cutthroat trout still exists in Bull Run Lake and Bull Run Reservoir 2 (ODFW 1997).

Historical. Historically, resident and migratory cutthroat trout were likely present in most reaches of the Sandy River Basin, where they were not excluded as a result of competition with other salmonid fishes. Cutthroat trout typically have a low position in the competitive hierarchy compared to other salmonid fishes (PGE 2002). They often occupy similar habitat to steelhead trout but are at a competitive disadvantage. Tributary reaches used by sea-run cutthroat trout for spawning are often located upstream of those used by coho salmon and steelhead trout. Historically, sea-run cutthroat trout were documented as migrating into the Sandy River from late summer through fall and using small tributaries for spawning (ODFW 1997). It is unknown how far into the upper Basin sea-run cutthroat trout migrated, but the fish likely utilized lower Basin tributaries. It is not known if sea-run populations were able to ascend the falls at Larson’s Bridge at RM 4.3 on the Bull Run River to access the upper reaches of the Bull Run watershed.

Abundance and Productivity

Data on the abundance of coastal cutthroat trout populations in the Sandy River Basin are very limited. Resident cutthroat trout populations are thought to be healthy in the upper Salmon River above Final Falls (~RM 14) and in Bull Run Reservoir 2. Populations located in remote reaches of the Basin are likely healthier than populations accessible to anglers. As recently as the 1970s, sea-run cutthroat trout were documented in small numbers (a few dozen) at the Sandy Hatchery weir and fish trap on Cedar Creek, but their recent presence has been very rare (ODFW 2002; ODFW 1997). Johnson et al. (1999) believed a dramatic decline in anadromous coastal cutthroat populations occurred across the distinct population segment, and the Sandy River Basin population is one of two on the brink of extinction.

Hatchery Production and Plantings

Current. Hatchery trout (cutthroat or rainbow) have not been released into the Sandy River Basin since 1994.

Historical. There are no reports of cutthroat trout releases into flowing waters of the Sandy River Basin. However, hatchery cutthroat trout were released into Mirror Lake.

Since the 1940s, rainbow trout have been released into upper Basin tributaries, primarily in Still Creek, Lost Creek, Camp Creek, Salmon River, and upper Sandy River (ODFW 1997). Three primary release sites were established in the upper Sandy River Basin from 1979 until stocking was discontinued in 1994: Salmon River, Lost Creek, and Camp Creek (ODFW 1997).

Photo courtesy of Burke Strobel.

Rainbow trout hatchery releases are noteworthy because cutthroat trout typically exhibit a high incidence of hybridization with rainbow trout (PGE 2002; Johnson et al. 1999). Hybridization of rainbow trout and cutthroat trout has also occurred in Bull Run Reservoir 1.

Harvest in the Basin

Current. Trout fishing in all flowing waters on the Oregon side of the distinct population segment is restricted to a late May to October 31 season. Catch-and-release restrictions have been put in place, and only artificial lures are permitted as terminal tackle. These regulations have resulted in reduced angling effort and provided protection for remaining populations of coastal cutthroat trout.

Historical. Because of their opportunistic, aggressive nature, cutthroat trout are susceptible to overexploitation, especially when they are confined to small streams. Historical harvest data concerning coastal cutthroat trout in the Sandy River Basin are extremely limited. Prior to 1995, liberal gear restrictions, trout seasons, and catch limits were in effect throughout much of the Sandy River Basin. Anecdotal information from old angler reports suggests that sea-run cutthroat trout once provided a significant fishery in the Sandy River (ODFW 1997).

Reasons for Decline/Threats to Survival

NMFS and USFWS identified the following factors as contributing to the decline of coastal cutthroat trout in the Southwest Washington/Columbia River DPS (NMFS and USFWS 1999):

- Habitat degradation from logging and other land management activities
- Degradation of estuarine habitats; recreational fishing and incidental catch
- Disease
- Negative effects of hatchery programs
- Inadequate regulatory mechanisms

Specific information about the decline of cutthroat trout in the Sandy River Basin is lacking. ODFW (1997) implied cutthroat trout populations may have been overharvested by angling, especially in the lower elevation reaches. The agency also suggested both instream and riparian habitat quality has been altered in several miles of the Salmon, Zigzag, and Upper Sandy rivers, and channelization activity likely removed significant low-velocity rearing habitat favored by cutthroat. Downstream of the Marmot Dam site, cutthroat trout have been affected by constructed barriers that have blocked significant portions of spawning and rearing habitat. Passage for trout migrants may have been affected in Beaver, Buck, Gordon, and Cedar creeks, and the Bull Run and Little Sandy rivers.

Figure 5-41 shows the estimated periods of occurrence for cutthroat trout in the Bull Run River.

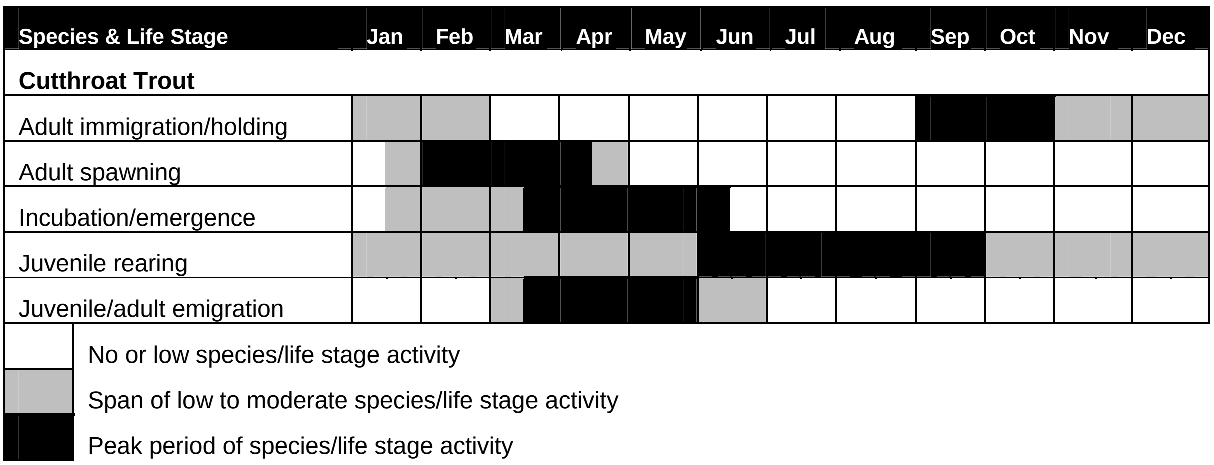


Figure 5-41. Estimated Periods of Occurrence for Cutthroat in the Bull Run River

Source: Sandy River Basin Agreement Technical Team 2002.

Pacific Lamprey

Pacific lamprey (*Lampetra tridentata)* are widely distributed throughout the North Pacific from Hokkaido Island, Japan, north and east to Alaska and south in North America to the Rio Santo Domingo in Baja California (Moyle 2002). They occur throughout coastal rivers and streams in Oregon and throughout the Columbia River Basin (Kostow 2002). Pacific lamprey are present in the Sandy River Basin (Strobel, pers. comm. 2006).

Life History and Diversity

Pacific lamprey are an anadromous and parasitic species. The parasitic phase is restricted to the marine environment, in which lamprey can attach to large fish and marine mammals. Adult lamprey leave the ocean to spawn in freshwater streams (Wydoski and Whitney 1979). Adult Pacific lamprey migrate upstream in July to October. They overwinter in fresh water and spawn from February through May in Oregon (Kostow 2002) when water temperatures are between 10 °C and 15 °C (Close et al. 1995). Both sexes construct a shallow nest in the stream gravel (Morrow 1976). Flowing water (1.6—3.3 feet per second [fps]) in low-gradient sections is preferred for spawning (Close et al. 1995). After preparation of the nest, the female attaches herself to a rock with her oral sucker and the male attaches to the head of the female. The male and female coil together while the eggs and sperm are released. The fertilized eggs adhere to the downstream portion of the nest (Moyle 1976) and then the adults cover the eggs with gravel. The process is repeated several times in the same nest site.

Spawning Pacific lamprey are often observed during steelhead spawning surveys, and they spawn in similar habitat (Jackson et al. 1996; Foley 1998). It is thought Pacific lamprey die after spawning, but a recent ODFW report documents observation of outmigrating lamprey and evidence of repeat spawning (Kostow 2002).

Juvenile Pacific lamprey, termed ammocoetes, swim up from the nest and are washed downstream, where they burrow into mud or sand to feed by filtering organic matter and algae (Moyle 1976). The ammocoetes generally remain buried in the substrate for five or six years, moving from site to site (Wydoski and Whitney 1979). Such an extended freshwater residence makes ammocoetes especially vulnerable to degraded stream and water quality conditions, including bedload disturbances. Larval lamprey transform to juveniles from July through October (Close et al. 1995). During this transition they become ready for a parasitic life stage, developing teeth, tongue, eyes, and the ability to adapt to saltwater. After metamorphosis, juvenile lamprey may remain in fresh water up to 10 months before passively migrating with the current downstream to the ocean in late winter or early spring (Wydoski and Whitney 1979).

After reaching the ocean, Pacific lamprey attach to and parasitically feed upon other fish (Moyle 1976). They may remain in saltwater for up to 3.5 years (Close et al. 1995). At maturity, Pacific lamprey may reach a length of approximately 70 centimeters (cm) (2.3 feet) (Hart 1973).

Pacific lamprey return to fresh water in the fall, overwinter, and spawn the subsequent spring (Close et al. 1995). Adults migrate into rivers and streams to spawn, sometimes traveling several hundred miles to the headwaters of streams. They do not feed during the spawning migration. Once in the streams, adults hide under rocks and other structures while undergoing reproductive maturation. Spawning sites of *L. tridentata* generally occur in low-gradient stream sections where gravel is deposited (Kan 1975). The nest sites are constructed at the tail areas of the pools and in riffles (Pletcher 1963; Kan 1975). Pacific lamprey spawning occurs over gravel with a mix of pebbles and sand (Mattson 1949; Kan 1975). Flow is also an important spawning requirement. Spawning occurs in lotic habitat with velocities ranging from 0.5 to 1.0 meter per second (1.6 to 3.3 fps) (Pletcher 1963; Kan 1975). The water depths where spawning occurs vary, ranging from 0.4 to 1.0 meter (1.3 to 3.3 feet) (Pletcher 1963; Kan 1975).

Ammocoetes move into habitats with slow currents and appropriate substrates. Close et al. (1995) noted high densities of ammocoetes found in floodplain sections of rivers with low gradients. In laboratory experiments, Pletcher (1963) determined that ammocoetes preferred, in relative order, mud (0.004 cm particle size), sand (0.005 cm particle size), and gravel (l.0 to 0.5 cm particle size). Burrowing was inhibited in water velocities greater than 0.305 meter per second (1.0 fps). Ammocoete beds in Oregon streams have been located in habitats with water velocities ranging from 0.1 to 0.5 meters per second (0.3 to 1.6 fps) (Kan 1975). Laboratory experiments have also shown that ammocoetes require appropriate levels of oxygen in the water. Under conditions of low partial pressures of oxygen (7 to 10 millimeters of mercury [mm Hg]) and temperatures of 15.5 °C, ammocoetes emerged from their burrows and died. Ammocoetes remained buried and survived under partial pressure of oxygen between 18 and 20 mm Hg (Potter et al. 1970). Although they reportedly prefer cold water (Close et al. 1995), ammocoetes have been found in waters ranging up to 25 °C in Idaho (Mallatt 1983).

Distribution

The City does not have much distribution information about lamprey in the Sandy River Basin. In the Bull Run watershed, there have been sporadic observations of dead Pacific lamprey in the lower six miles of the river (Kucas, pers. comm. 2005). In the past, arrivals of adult lamprey have been noted in the Bull Run River from late April through the fall (October to November), and these fish may have been Pacific lamprey (PGE 1982). In 1964, the City found juvenile lampreys (probably ammocoetes) in the water diversion pool immediately after construction of Bull Run Dam 2. The lamprey had found their way into the upper watershed because the sluice gates to the diversion pool were open during construction. Prior to that time, lamprey were not observed upstream of the dam. The City tried various remedies to block lamprey passage and eventually constructed a lamprey weir at approximately RM 5.9 on the mainstem Bull Run River.

Abundance and Productivity

Little information is available on the status of Pacific lamprey in the Sandy River Basin. Although previously petitioned for listing, Pacific lamprey have not been listed under the federal ESA. They are considered a federal species of concern and a state sensitive species in Oregon with a vulnerable ranking. No information was available on lamprey abundance in the Sandy River Basin. Data are available from two long-term counts at Columbia River dams and two dams on the Oregon coast (Kostow 2002). These data sets indicate this species may have declined from levels detected in 1970.

Reasons for Decline/Threats to Survival

Freshwater habitat degradation is likely the most significant threat to Pacific lamprey populations. Habitat issues potentially impacting lamprey ammocoetes include streambed siltation, water pollution, hydrologic modifications, and development in or above rearing areas (Kostow 2002). Migrating adult lamprey have difficulty negotiating fish ladders; thus in-channel structures, dams, and perched culverts could inhibit access to spawning habitats. In addition, lamprey are thought to be highly susceptible to injury and mortality at fish screens because of their small size.

Western Brook Lamprey

Almost all of the information on western brook lamprey (*Lampetra richardsoni*) comes from Kostow (2002), and that reference is heavily used for this species description. The nonparasitic western brook lamprey is probably the second most common and widely distributed lamprey in Oregon. ODFW acknowledges that there is very little information on brook lamprey, and most of the life history and behavior observations for the species come from a small tributary of the lower Fraser River in Canada (Pletcher 1963). Those observations are relied on in the descriptions that follow.

Life History and Diversity

Western brook lamprey, like Pacific lamprey and probably river lamprey, spawn in the spring. The eggs hatch according to the temperature of the water; hatching in Canada takes 15 to 20 days. After the larvae grow to about 7 to 10 mm long, they emerge and quickly move to silty areas to burrow. Brook lampreys distribute themselves within a creek system according to size, with smaller ammocoetes farther upstream and in finer silt deposits in shallower waters. They are filter feeders with a diet that is mostly diatoms. They likely undergo metamorphism after four to six years.

After metamorphosis, the western brook lamprey apparently enter deep burrows and become dormant. They stay in these burrows until about March, when they are ready to spawn. Readiness to spawn is temperature-dependent, and they will remain in the burrows until water temperatures reach above 10 °C. When they emerge as sexually mature fish, they range in size from 8 to 17 cm.

Western brook lampreys do not appear to move very much during their lives. Most of their movement is passive downstream movement when they leave their burrows.

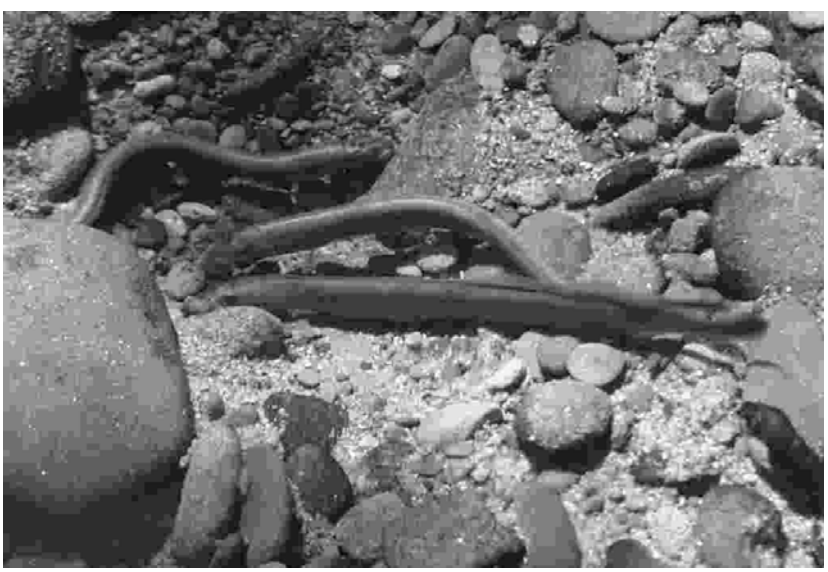


Photo courtesy of ODFW.

Distribution

Distribution information for western brook lamprey in the Sandy River Basin is not available.

Abundance and Productivity

The City does not have any information on abundance or productivity of western brook lamprey in the Sandy River Basin.

Reasons for Decline/Threats to Survival

As is the case for Pacific lamprey, freshwater habitat degradation is likely the most significant threat to western brook lamprey populations. Habitat issues potentially impacting lamprey ammocoetes include streambed siltation, water pollution, hydrologic modifications, and development in or above rearing areas (Kostow 2002). Migrating adult lamprey have difficulty negotiating fish ladders, thus in-channel structures, dams, and perched culverts could inhibit access to spawning habitats. In addition, when migrating downstream to the ocean, lamprey are thought to be highly susceptible to injury and mortality at fish screens because of their small size.

River Lamprey

The small parasitic river lamprey is the sister species of the western brook lamprey (Kostow 2002). The distribution of river lamprey extends from the Sacramento River to southeast Alaska and inland in the Columbia River to the Columbia River Gorge (Kan 1975; Lee et al. 1980). ODFW staff do not believe they have observed river lamprey in many years and have no information about the species. The little information that is available about river lamprey is based on observations in the Fraser River and Georgia Straight in Canada (Beamish 1980; Beamish and Youson 1987). No information is available about their early life history or habitat preferences.

River lampreys spend most of their life in fresh water. In the spring following metamorphosis, development of their oral feeding discs is complete, and they enter the ocean to feed. River lamprey enter saltwater between May and July and promptly begin feeding. They remain close to shore and are found mostly near the mouths of the rivers that produced them. River lamprey remain in the ocean for only about 10 weeks. They leave saltwater in September when they are about 25 cm long (Beamish and Youson 1987). They are assumed to spawn the following spring, although adults are rarely seen in fresh water.

During the brief periods that river lamprey are distinctive in fresh water, they are not seen, probably because they are in deep-water habitats in the mainstems of larger rivers (Beamish and Youson 1987). They may prefer larger rivers, including the Fraser, Columbia, and Sacramento (Kan 1975).

The City has no specific information on life history, distribution, or abundance of river lamprey in the Sandy River Basin. Likewise, the City does not know the specific reasons for their decline or the threats for survival for the species. The City assumes that many of the factors affecting the freshwater habitat of river lamprey would be similar to those of Pacific and western brook lamprey.

5.5 Amphibians and Reptiles

Ten amphibians and reptiles will benefit from the HCP measures: Cope's giant salamander, the cascade torrent salamander, the clouded salamander, the Oregon slender salamander, the coastal tailed frog, the northern red-legged frog, the Cascades frog, the western toad, the western painted turtle, and the northwestern pond turtle. Species with adequate information are described in terms of their species status, life history, habitat needs, and distribution in the Sandy River Basin. Information on other species is reported as it is available.

5.5.1 Amphibians

Western Toad (*Bufo boreas*)

Species Status

The western toad is currently classified as a Sensitive – Vulnerable species in Oregon (ODFW 2005c). Although the species has disappeared from many former breeding sites, it is still common at others (Oregon Natural Heritage Information Center 2003; NatureServe 2005). The species is adapted to such disturbances as flood scour, fire, and even volcanic eruption, but populations may dwindle as plant succession progresses (Corn 1993). Western toads appear to be particularly susceptible to fungal diseases that have emerged recently and are occurring globally (Blaustein and Wake 1990; Blaustein and Olson 1991; Blaustein et al. 1994; Stebbins and Cohen 1995; Kiesecker and Blaustein 1997; Daszak et al. 1999).

Life History

The western toad has aquatic egg and larval stages and a terrestrial adult stage. The timing of breeding is strongly dependent on the phenology of the individual site. For example, at sunny sites at 4,000 feet, breeding may occur immediately after snowmelt in early April. At riverine sites at 500 feet, breeding may not occur until after water temperatures have warmed up in June. Each female can lay up to 16,000 eggs in long strands that are laid communally and often form extensive mats. In warm weather, eggs can hatch within five days, and hatchlings may begin feeding after one or two days.

Tadpoles forage on organic mud, diatoms, and tree pollen; however, they are also scavengers, scraping protein from flesh or fish guts. They frequently form vast swarms that move in one direction, maintaining warmth and safety in numbers rather than fleeing or hiding from garter snakes, predaceous aquatic insects, and other predators. Metamorphosis occurs in mid- to late- summer, with toadlets dispersing en masse as they begin to capture small flying insects and ants.

Adults prey on invertebrates such as insects, spiders, earthworms and slugs. Western toads reach sexual maturity in two to three years. Adults may live for 10 years or more, but females do not produce eggs every year. Adults are vulnerable to predation by ravens and raccoons, particularly when gathered for breeding. (Nussbaum et al. 1983; Olson 1989; Leonard et al. 1993; Koch and Peterson 1995; Stebbins and Cohen 1995; Corkran and Thoms 1996; Hallock and McAllister 2005; and Corkran, unpublished data).

Photo courtesy of Char Corkran.

Habitat Needs

Spanning the Northwest from the Rocky Mountains to the Pacific Coast, and from northern Baja California to southeast Alaska, the western toad's broad geographic range encompasses many physiographic provinces. It occurs from near sea level to about 10,000 feet in elevation (Stebbins 1966; NatureServe 2005).

A habitat generalist, the western toad is found in alpine meadows, coastal river bottoms, and semiarid lands. Breeding sites include shallow ponds, lake or reservoir edges, and river overflow channels. Sites having no shade and a mud or sand substrate with sparse vegetation are generally chosen. Egg strings are usually laid on the bottom in water 4—15 inches deep, but in high water years they are draped over flooded shrubs close to the surface. Larvae seek the warmest available micro-sites: sunny shallows during the day and mud, rotting vegetation, or geothermal springs at night. Metamorphs hide under rocks and logs, then disperse to sunny meadows or open woods. Juveniles and adults hide during the day, as well as hibernate, by burying themselves in duff and loose soil or retreating into large mammal tracks, rodent burrows, and rotting logs. In hot, dry weather they also use springs, stream edges, and moist riparian areas. Western toads have been documented traveling three miles or more from breeding sites during the year. The foregoing discussion of habitat use is based on Nussbaum et al. (1983), Leonard et al. (1993), Koch and Peterson (1995), Corkran and Thoms (1996), Bartelt et al. (2004), Thompson (2004), Hallock and McAllister (2005), NatureServe (2005), and Corkran (unpublished data).

Distribution in the Sandy River Basin

Only one breeding population of western toad is known in the Sandy River Basin: Bull Run Reservoir 1, where an extensive bench on the north side is inundated at full pool (Corkran, unpublished data). Although adult toads are found in the upper Salmon River drainage, they do not breed there.

Cascades Frog (Rana cascadae)

Species Status

The Cascades frog is classified as a federal Species of Concern and a Sensitive – Vulnerable species in Oregon (ODFW 2005c). Declining population trends and lack of breeding at many of the historical localities, apparently caused by infectious diseases and anthropogenic factors, are reasons for the current classifications (Blaustein and Wake 1990; Blaustein and Olson 1991; Fellers and Drost 1993; Blaustein et al. 1994; Kiesecker and Blaustein 1997; Oregon Natural Heritage Information Center 2003; NatureServe 2005).

Life History

Typical of its genus, the Cascades frog has aquatic egg and larval stages and a primarily terrestrial adult stage. Breeding occurs as soon as snow and ice melt at a given site. Each female lays from 100 to 500 eggs in a single mass, and frequently several females deposit their egg masses in one pile. Eggs usually hatch in one to three weeks, depending on water temperature. Hatchlings spend several days on the egg mass before beginning to forage by scraping diatoms, algae, and rotting vegetation, and by filtering micro-organisms. Water temperature, food supply, and crowding of larvae determine the time to metamorphosis, usually two to three months, although some tadpoles survive a winter before transforming. Metamorphs may disperse from the breeding site after they begin foraging on a variety of crawling and flying invertebrates. Males and females reach sexual maturity in about three years, and may not live longer than about five years. (Sype 1975; Nussbaum et al. 1983; Olson 1988; Leonard et al. 1993; Corkran and Thoms 1996; Hallock and McAllister 2005; Corkran, unpublished data.)

Habitat Needs

Although its range extends from northern California to the British Columbia border, the Cascades frog is restricted to a narrow belt in the Cascade Mountains, including both sides of the crest. A separate population occurs in the Olympic Mountains of western Washington. Most of the habitat occupied by this species is between 2,500 and 6,500 feet in elevation. (Nussbaum et al. 1983; Leonard et al. 1993; and Corkran and Thoms 1996).

Predominantly a species of mountain wetlands, the Cascades frog uses separate habitat types for different stages of its life cycle. Breeding sites have shallow water, usually less than seven inches deep, with no shading trees or shrubs. The north edges of ponds or lakes, as well as elk wallows or other pools in wet meadows, provide ideal breeding habitat. Egg masses are deposited at the water surface on moss or other low vegetation at the margin of pools, where rain and snowmelt can carry the hatchlings to deeper water. Older larvae congregate in sunny shallows for foraging and basking, often using submerged rocks or logs as heat reservoirs and shelves near the surface. They utilize deeper water and dense aquatic or emergent vegetation to escape garter snakes, dragonfly larvae, and other predators. At metamorphosis, froglets leave the pooled water and disperse into surrounding wet meadow vegetation, where they may also hide under logs and rocks from predators that include a variety of mammals, birds, and garter snakes. As hot weather dries the meadows in summer and fall, metamorphs move back to well-vegetated pond edges or follow flowing water to join adults along shaded streams, where they hide under logs and rocks. During wet weather, Cascades frogs may forage well away from water in riparian forest, shrub, and meadow habitats, but may not travel more than 0.5 mile from the breeding site during the year. They probably hibernate in the mud of wet meadows or low-gradient stream edges. (Nussbaum et al. 1983, Olson 1988, Leonard et al. 1993; Corkran and Thoms 1996; Richter 1997; Hallock and McAllister 2005; and Corkran, unpublished data.)

Distribution in the Sandy River Basin

Within the Sandy River Basin, Cascades frogs are common only in higher elevations, where wet meadows occur on relatively level terrain (Corkran, unpublished data). They are largely absent from steep forested ridges and low elevations. The largest populations occur near the southern edge of the Basin at several headwaters of the Salmon River, and in the south buffer of the Bull Run watershed at the head of the Little Sandy River. Smaller populations occur near the outlet of Bull Run Lake, near Latourell Prairie, and at the head of Cedar Creek on Wildcat Mountain. One of the lowest known elevation breeding sites occurred north of Bull Run Reservoir 1 at 1,650 feet, but the small site has filled in and is no longer used by Cascades frogs.

Northern Red-legged Frog (*Rana aurora aurora*)

Species Status

The northern red-legged frog is currently classified as a federal Species of Concern and a Sensitive – Undetermined status species in Oregon, except in the Willamette Valley where it is considered Sensitive – Vulnerable (ODFW 2005c). Habitat loss, predation by introduced warm-water fish and American bullfrogs (*Rana catesbeiana*), pesticides, and other pollutants are thought to have impacted Willamette Valley populations, but in other regions of Oregon, numbers of northern red-legged frogs appear to be more stable (Oregon Natural Heritage Information Center 2003; NatureServe 2005).

Life History

Like most of the regional frog species, the northern red-legged frog has aquatic egg and larval stages and a mostly terrestrial adult stage. Its life history, as discussed here, is derived from Nussbaum et al. (1983), Leonard et al. (1993), Stebbins and Cohen (1995), Corkran and Thoms (1996), Hallock and McAllister (2005), and Corkran (unpublished data). The northern red-legged frog is usually one of the two earliest amphibian species to breed, laying eggs in February and occasionally in December. Each female lays a single egg mass containing 500 to 1,300 eggs, and the egg masses are usually scattered around the site. Periods of cold weather often delay embryo development, and eggs do not hatch for four to six weeks. For a few days the hatchlings cling to the egg mass or vegetation, until they begin feeding by filtering micro-organisms and scraping diatoms, algae, and rotting vegetation. Tadpoles metamorphose in early to mid-summer, depending on water temperature. As they disperse from breeding sites, froglets begin foraging on small flying insects; as they grow, they catch a variety of flying and crawling invertebrates. Sexual maturity may be reached at two years of age, and red-legged frogs appear to breed every year. Predators include raccoons, other semiaquatic mammals, herons, and other large birds. Longevity may exceed five years.

Habitat Needs

Extending from the northwestern corner of California to the southwestern coast of British Columbia, including Vancouver Island, populations are widespread from the Pacific coast to the western slopes of the Cascade Mountains. The northern red-legged frog generally occurs from near sea level to about 2,500 feet elevation; however, a few populations in Oregon reach the Cascades crest at 4,500 feet or more (Nussbaum et al. 1983; Leonard et al. 1993; Corkran and Thoms 1996; and NatureServe 2005).

Strongly associated with streams and wetlands in a variety of forest types, the red-legged frog uses several habitats during the year. Typical breeding sites include beaver ponds, lake edges, sag ponds, overflow ponds, and backwaters of slow streams. The eggs are intolerant of warm temperatures, so breeding ponds are either deep, partially shaded, or having slight inflow from a stream or spring. Egg masses are attached to emergent or flooded vegetation, often the tops of sedge clumps or small willows, usually well below the surface in water 20 to 40 inches deep. Tadpoles forage and bask near the water surface and in the shallows of deeper ponds. They actively avoid predators, such as garter snakes, fish, and predaceous insect larvae, by swimming rapidly to deep water or diving into the bottom mud or dense aquatic vegetation. After metamorphosis, froglets usually disperse through wetland vegetation or along brushy streams, hiding under logs and rocks. Red-legged frogs often forage in moist deciduous or coniferous forests well away from streams in wet weather. During hot, dry periods they remain at stream edges and in riparian forests. They sit on rocks or on logs adjacent to or suspended above streams, awaiting flying insect prey and avoiding desiccation and overheating. They hibernate in wetland mud and rodent burrows with entrances under logs or bark. Travel distances during the year may be several miles from the breeding site. (Nussbaum et al. 1983; Leonard et al. 1993; Blaustein et al. 1995; Corkran and Thoms 1996; Richter 1997; Hallock and McAllister 2005; and Corkran, unpublished data.)

Distribution in the Sandy River Basin

Red-legged frogs are widely distributed in the Sandy River Basin up to about 2,000 feet in elevation (Corkran, unpublished data). A large and apparently stable population of approximately 600 frogs breeds in shallows at the head of Bull Run Reservoir 1, although annual productivity is not well monitored. Other large aggregations breed in ponds near the south side of Reservoir 2 and in a beaver pond on a small tributary of the Sandy River near Brightwood. Numerous small breeding sites occur in the lower Basin, where they are vulnerable to invasion by American bullfrogs and particularly by warm-water fish. In recent years, red-legged frogs have not been observed at several former breeding sites at the Sandy River delta.

Coastal Tailed Frog (*Ascaphus truei*)

Species Status

The coastal tailed frog is classified as a federal Species of Concern and a Sensitive – Vulnerable species in Oregon (ODFW 2005c). Irregular distribution and evidence of declining population trends, mostly caused by habitat loss or degradation, are reasons for its current classification (Oregon Natural Heritage Information Center 2003; NatureServe 2005).

Life History

The coastal tailed frog has egg, larval, and adult stages distinctively adapted to streams, although adults are also partially terrestrial. This species mates during low flows in early autumn, and internal fertilization prevents sperm from being carried away by the stream current. Females do not lay their strings of 30 to 50 eggs until the following mid-summer. The eggs hatch late in the summer, and hatchlings continue using their internal yolk for several months. Larger tadpoles forage by scraping diatoms and algae from rocks while clinging with their large mouths, which are modified for suction. Tadpoles often hide on the undersides of rocks during the day; if disturbed, they swim to the stream bottom and push down between cobbles. Metamorphosis does not occur for one to four years, depending on stream temperature. Adults prey on aquatic, terrestrial, and aerial invertebrates. Predators include fish, aquatic salamanders, various mammals, the American dipper (*Cinclus mexicanus*), and probably other birds as well. Sexual maturity is not reached for three to six years, and females probably only breed every other year. Longevity is not known. (Nussbaum et al. 1983; Brown 1989; Adams 1993; Leonard et al. 1993; and Corkran and Thoms 1996.)

Habitat Needs

Extending from northern California to the western fringe of British Columbia, the coastal tailed frog's geographic distribution is restricted to streams in the Coast Range and the Cascade and Olympic Mountains. Its elevation range is from near sea level in the Coast Range to about 5,000 feet (Nussbaum et al. 1983; Leonard et al. 1993; Corkran and Thoms 1996; NatureServe 2005).

Photo courtesy of Char Corkran.

Closely tied to forested mountain streams, the coastal tailed frog uses a limited range of habitats throughout its life. Coastal tailed frogs are entirely dependent on cold streams with moderate to high gradient and little or no silt. Occupied streams are usually in old-growth forests. Breeding sites are not well known, but eggs are apparently deposited under boulders in stream pools with moderate flow. Hatchlings remain in the egg site and under the protected edges of the nest boulder until their mouths develop. Tadpoles require rocks with a fairly smooth-grained surface and no accumulations of silt, moss, or other vegetation that would interrupt their ability to adhere using their suction mouths. Unable to swim against a strong current if dislodged and when moving from one rock to another while foraging, tadpoles may gradually move downstream during their lengthy development. Metamorphs appear to move upstream, using the very shallow stream edges and hiding under cobbles or large gravel. Some dispersal and adult migration does occur overland. Adults are most frequently found in small tributary streams and headwaters, where they may remain year-round except during breeding. During the day, they hide under rocks in shallow stream edges or on land in or under large logs. At night and during rainy weather, coastal tailed frog adults forage in riparian woods 100 feet or more from the water. Distances traveled during the year are unknown but may exceed 0.5 mile. (Nussbaum et al. 1983; Bury and Corn 1988; Brown 1989; Corn and Bury 1989; Welsh 1990; Bury et al. 1991a; Bury et al. 1991b; Gilbert and Allwine 1991; Adams 1993; Leonard et al. 1993; and Corkran and Thoms 1996).

Distribution in the Sandy River Basin

Coastal tailed frogs are widespread within the upper Sandy River Basin, except for the major rivers and streams. They occur in many of the tributaries of the upper Bull Run, Sandy, and Salmon rivers and upper Gordon Creek. In the upper Bull Run watershed, these frogs have been observed at the mouths of the tiny streams that trickle down into the upper reservoir. Populations have not been systematically monitored, but they appear to be stable (Corkran, unpublished data).

Cope's Giant Salamander (*Dicamptodon copei*)

Species Status

The Cope's giant salamander is classified as a Sensitive – Undetermined Status species in Oregon (ODFW 2005c). Reasons for this classification are that several aspects of its life history are still unknown; its population size and trend are unknown; and it is vulnerable to logging, road building, and other activities that increase sedimentation in streams (Bury et al. 1991b; Oregon Natural Heritage Information Center 2003; NatureServe 2005).

Life History

The Cope's giant salamander has aquatic egg and larval stages and is normally neotenic, becoming sexually mature while remaining in a larval stage. Breeding apparently occurs from spring through early fall. Each female lays 25 to 115 eggs and guards them from predation, mostly by other giant salamanders. Hatchlings may remain in the nest until eight months after the eggs were laid, when they emerge and begin to feed on small invertebrates. Larger larvae prey on invertebrates that dwell in or fall into streams, small fish and their eggs, and small amphibians, including young of their own species. These salamanders are often nocturnal, hiding during the day from predators that probably include river otter (*Lutra canadensis*), water shrews (*Sorex* spp.), garter snakes (*Thamnophis* spp.), fish, and larger giant salamanders (*D. copei* as well as *D. tenebrosus*). Age at sexual maturity is unknown but is likely to be more than two years. Females probably do not breed every year. Longevity is unknown. (Nussbaum 1970; Nussbaum et al. 1983; Leonard et al. 1993; Corkran and Thoms 1996; Fiedler 2001; Jones 2001; Hallock and McAllister 2005; and Corkran, unpublished data.)

Habitat Needs

Although the geographic range of the Cope's giant salamander is still not completely known, it mainly occurs in certain streams in western Washington and northwestern Oregon. Populations in Washington are in the Olympic Mountains, Willapa Hills, and southwestern Cascade Mountains. In Oregon, this species occurs in the extreme northern Coast Range and Cascade Mountains, including the Columbia Gorge, but it also occurs around the eastern slopes of the Mt. Hood National Forest. Its elevation range is from near sea level to about 5,200 feet (Leonard et al. 1993; Corkran and Thoms 1996; NatureServe 2005; Corkran, unpublished data).

Dependent on forested mountain streams, Cope's giant salamanders use a restricted range of habitats throughout their lives. Streams with cold water, moderate to high gradient, and a cobble or small boulder substrate with no silt are occupied year-round. Mating sites are unknown. Females choose aquatic nest sites under boulders or streambank ledges, or in spaces inside or under logs in the streambed. Hatchlings move to shallow stream edges with small cobble substrate, where they can avoid predation by larger salamanders that cannot penetrate the small interstitial spaces. Larger adults may use pools more frequently than riffles, and usually the size of the rock or wood cover object chosen is proportional to the size of the individual. Cope's giant salamanders have been observed foraging at night at the head of stream pools, utilizing positions held by cutthroat trout (*Oncorhynchus clarki*) in the daytime. During heavy rains, larvae leave the streams at night to forage along the edge. The few metamorphosed adults that have been found (all in Washington) were on rocky stream banks. Although the species is not known to travel far in a year, it potentially disperses overland during wet weather. (Murphy and Hall 1981; Nussbaum et al. 1983; Bury et al. 1991b; Leonard et al. 1993; Corkran and Thoms 1996; Fiedler 2001; and Jones 2001; and Corkran, unpublished data.)

Photo courtesy of Char Corkran.

Distribution in the Sandy River Basin

The Cope's giant salamander is sporadically distributed in the upper Sandy River Basin. Known populations occur in the headwaters and many smaller tributaries of the Bull Run River, in Still Creek, Mud Creek, Gordon Creek, and Cedar Creek, which is near the southwestern edge of its known range (Corkran, unpublished data). Little is known about its population status in the Basin.

Cascade Torrent Salamander (*Rhyacotriton cascadae*)

Species Status

The Cascade torrent salamander is currently classified as a Sensitive – Vulnerable species in Oregon (ODFW 2005c). Formerly considered a disjunct population of the Olympic salamander (*R. olympicus*), it was recently recognized as a separate species (Good and Wake 1992). Its susceptibility to warmed water and sediment in streams means that it is threatened by logging, road building, or other ground-disturbing activities that affect its habitat (Murphy and Hall 1981; Bury and Corn 1988; Corn and Bury 1989; Bury et al. 1991b; and Oregon Natural Heritage Information Center 2003). Restricted to particular streams on the west slope of the Cascade Mountains in Oregon and southern Washington, the Cascade torrent salamander occurs from near sea level to about 4,000 feet in elevation (Nussbaum et al. 1983; Leonard et al. 1993; Corkran and Thoms 1996; NatureServe 2005).

Life History

The Cascade torrent salamander has aquatic egg and larval stages, and the adults are primarily aquatic also. Breeding behavior and timing for the torrent salamanders are not well known. Probably most eggs are laid in spring, and females may not produce more than about eight eggs each. Eggs are laid communally but apparently none of the females guard them. They probably do not hatch for more than nine months, and hatchlings may not leave the nest and begin feeding until a year after the eggs are laid. Hatchlings, larger larvae, and adults all consume a variety of small, aquatic and stream-edge invertebrates. Predators probably include both Cope's and Pacific giant salamanders, fish, water shrews, and possibly weasels (*Mustela* spp.) and American dipper. Larvae metamorphose at four or five years of age and reach sexual maturity at five to six years. Females may breed annually. Lifespan is unknown. (Murphy and Hall 1981; Nussbaum et al. 1983; Leonard et al. 1993; Corkran and Thoms 1996; Nijhuis and Kaplan 1998; Morrissey and Olenick 2004; and Hallock and McAllister 2005.)

Habitat Needs

Reliant upon forested mountain streams, the Cascade torrent salamander uses a narrow set of habitats during its life. Cold, silt-free water and a substrate derived from basalt or other hard, fine-grained rock are basic requirements. Mating sites are unknown. Females lay eggs unattached in rock crevices through which water seeps permanently. Recently emerged hatchlings have been found in very fine gravel at the base of a mossy, fractured rock outcrop that is presumed to be a nest site. As they grow, larvae move to stream edges where water is shallow, often less than 0.5 inches deep. Larvae and adults use the same sites, usually well-shaded stream edges and side channels, seeps through fractured rock or extensive gravel beds, and the splash zones at the base of waterfalls. Some occupied sites have heavy growths of aquatic mosses, while others are entirely free of moss. Observations that Cascade torrent salamanders occur in streams that flow subsurface during dry weather indicate the possibility that this species uses the hyporrheic zone of some stream systems. Although occasionally seen on the surface in daylight, these small salamanders usually hide during the day under small cobble and in gravel. They actively flee predators by twisting down into the substrate where larger animals cannot pursue. Apparently quite sedentary, there is some evidence that larvae move upstream. During prolonged wet weather, adults are often observed under rocks and woody debris on the streambank. Occasional sightings 100 feet from water may indicate the potential for overland dispersal between small streams. (Nussbaum et al. 1983; Bury and Corn 1988; Corn and Bury 1989; Bury et al. 1991a; Bury et al. 1991b; Leonard et al. 1993; Corkran and Thoms 1996; Nijhuis and Kaplan 1998; and Corkran, unpublished data.)

Distribution in the Sandy River Basin

The Cascade torrent salamander has much the same distribution as the Cope's giant salamander in the Sandy River Basin, known to occur only in the headwaters of the Bull Run River and its tributaries, and several other small streams in the Basin (Corkran, unpublished data). Little is known about its population status in the Basin.

Clouded Salamander (*Aneides ferreus*)

Species Status

The clouded salamander is classified as a Sensitive – Vulnerable species in Oregon (ODFW 2005c). This salamander apparently evolved to take advantage of stand-replacing forest fires that left an abundance of large-diameter logs, a habitat condition that is now rare. Infrequently encountered in most of its range, it can be difficult to take a meaningful census. (Gilbert and Allwine 1991; Corkran and Thoms 1996; Vesely 1999; Oregon Natural Heritage Information Center 2004; and Corkran, unpublished data.)

Life History

Typical of the family Plethodontidae, the clouded salamander is a fully terrestrial species with no larval stage. Breeding occurs in spring and early summer. Each female lays between 8 and 24 eggs, and both females and males have been found to remain with them until they hatch. During early fall rains, hatchlings begin to disperse and forage for small arthropods. Agile and strong, this salamander frequently evades capture by rapid scrambling and is capable of both jumping and climbing to avoid predation, probably by weasels, shrews, and snakes. Adults feed on small arthropods, primarily ants. Males become sexually mature in two or three years and females in three or four years. Females probably breed only every other year. Longevity is unknown. (Nussbaum et al. 1983; Leonard et al. 1993; Blaustein et al. 1995; and Corkran and Thoms 1996.)

Habitat Needs

With the recent split of *Aneides vagrans* and *A. ferreus*, the clouded salamander's geographic range is now mostly in Oregon, extending from northern California to the Columbia River. It is most often found in the Coast Range and central portion of the west slope of the Oregon Cascade Mountains, but does not appear to be common anywhere. Occupied sites are between sea level and about 5,000 feet. (Nussbaum et al. 1983; Leonard et al. 1993; Blaustein et al. 1995; Corkran and Thoms 1996.)

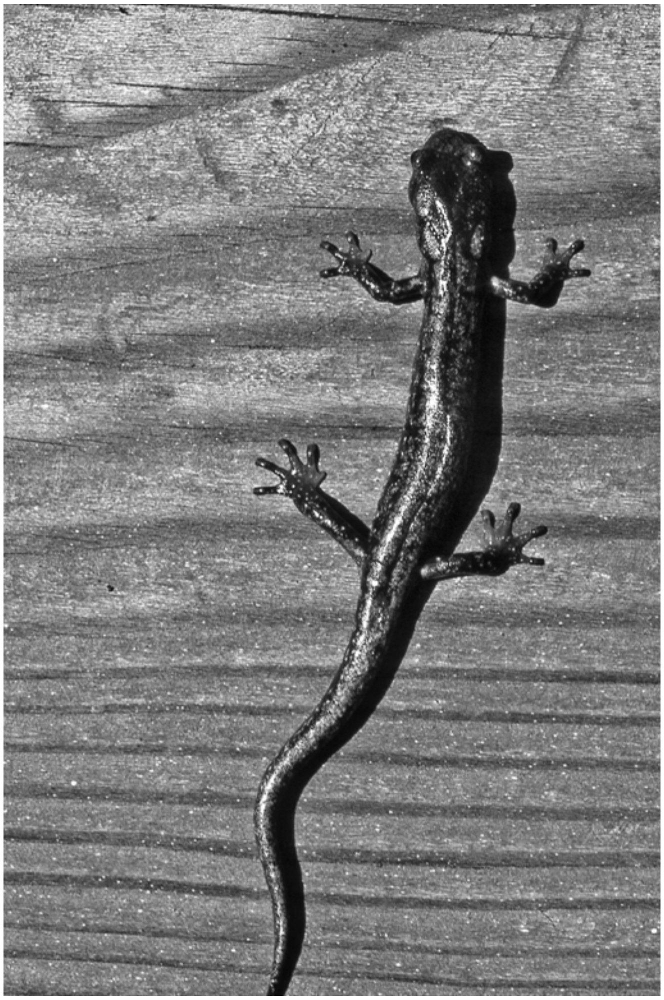


Photo courtesy of Char Corkran.

Strongly associated with conifer forests and forested talus or rock outcrops, clouded salamanders utilize a limited range of habitat types year-round. The nest site is a small cavity in a log or between rocks, and eggs are suspended from the ceiling. Juveniles and adults are found most often in large-diameter Douglas-fir (*Pseudotsuga menziesii*) logs, often in small openings in the forest canopy. Two types of logs are used. Fairly fresh logs, usually Decay Stage 2 (Maser et al. 1979) with slightly loosened bark and hard interior wood, particularly logs with long splits in the wood, are frequently used, perhaps mostly for foraging and hiding. More rotted logs (usually Decay Stage 4) with interior wood that breaks into blocks and layers probably are used most often for nesting and retreating from dry, hot, or freezing weather conditions, but seasonal movements of this species are largely unknown. Clouded salamanders also climb on snags to forage, and use talus and fractured rock outcrops where fairly stable, moist conditions exist. Small populations persist in several urban areas with crumbling rock foundations. This salamander is often present in riparian forests, but appears to show no preference for that habitat over upland sites. Although no studies have been conducted, this species may be capable of traveling considerable distances during wet weather. (Nussbaum et al. 1983; Bury et al. 1991a; Leonard et al. 1993; Blaustein et al. 1995; Corkran and Thoms 1996; and Corkran, unpublished data.)

Distribution in the Sandy River Basin

The clouded salamander is widely distributed but uncommon in the Sandy River Basin, which is near the northern end of its geographic range. Individuals have been found at several locations in the Bull Run watershed and at one site next to the Salmon River. In the Bull Run watershed, clouded salamanders have been observed primarily in large, downed trees at the edges of Reservoir 1 (Corkran, unpublished data).

Oregon Slender Salamander (*Batrachoseps wrightorum* [= *wrighti*])

Species Status

The Oregon slender salamander is classified as a federal Species of Concern and a Sensitive – Undetermined Status species in Oregon (ODFW 2005c). This state classification reflects its restricted distribution, its incompletely known life history, and its close association with large-diameter logs and old-growth conifer forest conditions (Vesely 1999; Oregon Natural Heritage Information Center 2004).

Life History

As a member of the family Plethodontidae, the Oregon slender salamander is a fully terrestrial species with no larval stage. The reproductive biology of this species is incompletely known. Breeding occurs through spring and early summer. Frequently two or more of these salamanders are found under the same cover object, but mating habits are not well known. Each female lays between 3 and 11 eggs and often stays with the eggs until they hatch during the fall. Hatchling behavior is not known. Adults prey on a variety of small invertebrates, especially collembolans and mites. Oregon slender salamanders usually coil up tightly to hide from predators that may include shrews, snakes, and larger salamanders. If caught, the tail may drop off and wriggle while the salamander escapes. The length of time to reach sexual maturity, breeding frequency for females, and longevity are not known. (Nussbaum et al. 1983; Leonard et al. 1993; Blaustein et al. 1995; and Corkran and Thoms 1996).

Habitat Needs

Endemic to the Cascade Mountains in Oregon, this salamander species occurs only from the Columbia River south to southern Lane County. Although its known range has recently been expanded to include sites on the east side of the Mt. Hood National Forest, it primarily occurs on the west slope of the Cascades. Its elevation range is from near sea level in the Columbia River Gorge to about 4,400 feet. (Nussbaum et al. 1983; Leonard et al. 1993; Blaustein et al. 1995; Corkran and Thoms 1996.)

Usually associated with old-growth Douglas-fir forest or forested talus, the Oregon slender salamander uses a restricted set of habitat variables throughout its life. Nests have been found in small crevices inside large logs and under bark on top of logs. Juveniles and adults use small hiding spaces, primarily provided in older debris piles around the base of large Douglas-fir snags or in fairly well rotted Douglas-fir logs (usually Decay Stage 4 [Maser et al. 1979]) with interior wood that breaks into small blocks and layers. Individuals also use the space under bark of Decay Stage 2 or Decay Stage 3 logs. This species also occurs in talus slopes where forest canopy, moss, and abundant quantities of fine debris retain moisture. East of the Cascade Mountains crest, it is found either in lava flow areas or under a greater variety of wood debris than on the west side. During prolonged rainy periods, especially in spring, these salamanders spend more time at the surface, hiding during the day under large sheets of bark, rocks, or sometimes smaller debris. During dry periods in late summer and during subfreezing weather, they apparently retreat underground, probably beneath logs that minimize moisture and temperature changes, or in stable talus slopes. Oregon slender salamanders are sometimes present in coniferous riparian forests, but apparently show no preference for them over upland forests. The short legs of this species would seem to indicate that it cannot travel far, but there are no data on movement distances of individual salamanders. (Nussbaum et al. 1983; Bury et al. 1991a; Gilbert and Allwine 1991; Leonard et al. 1993; Blaustein et al. 1995; Corkran and Thoms 1996; Vesely 1999; Thurman 2005; and Corkran, unpublished data.)

Distribution in the Sandy River Basin

The Oregon slender salamander is widely distributed in the majority of the Sandy River Basin that is covered by coniferous forest, but its occurrence is probably very patchy. Old-growth stands in the Bull Run watershed and along the Salmon River harbor large populations of this species (Gilbert and Allwine 1991; Corkran, unpublished data).

5.5.2 Reptiles

Western Painted Turtle (*Chrysemys picta belli*)

Species Status

The western painted turtle is classified as a Sensitive – Critical species in Oregon (ODFW 2005c). Although it is still found in large numbers, many sites have predominantly older individuals because nest predation by raccoons and predation of hatchlings and juveniles by exotic warm-water fish and American bullfrogs limit recruitment into most populations (Northwest Ecological Research Institute 1998; Oregon Natural Heritage Information Center 2003; NatureServe 2005).

Life History

The western painted turtle is principally an aquatic species, but it lays its eggs in terrestrial nests. Mating occurs in early spring (possibly also in the fall). Females lay 1—20 hard-shelled eggs in mid-summer, after building up yolk reserves by foraging and basking. Each female leaves the water and lays eggs in a hole dug with the back legs, partially plugging the hole with dirt using the back legs and plastron (lower shell). The eggs hatch in late summer or fall, but many hatchlings remain in the nest until early the following spring when they move to water. Hatchlings eat small invertebrates and some vegetation; adults may eat proportionately more aquatic plants, but also catch snails, crayfish, earthworms, small fish, tadpoles, and eat carrion. Turtles forage by swimming slowly at or below the surface. Because basking is important for thermoregulation, prevention of skin diseases and

Photo courtesy of Char Corkran.

parasites, and egg production in females, all ages of turtles spend many hours a day at it. If a potential predator is noticed, the turtles dive suddenly from the surface or off of basking sites and swim rapidly to the bottom. Predators of larger juveniles and adults include terrestrial and semiaquatic mammals and birds. Males reach sexual maturity in three to four years; females not for five to eight years. Most females lay eggs annually. Some individual turtles may live to be 30 years old. (Nussbaum et al. 1983; Storm and Leonard 1995; Blood and Macartney 1998; and St. John 2002.)

Habitat Needs

Primarily occurring in the interior Columbia River Basin, the western painted turtle's range extends from southern British Columbia to the Willamette Valley. A smaller population occurs around Puget Sound in Washington. Occupied sites reach from near sea level to about 3,500 feet in eastern Washington (Nussbaum et al. 1983; Storm and Leonard 1995; Blood and Macartney 1998; St. John 2002).

Associated with large, slow rivers and extensive wetlands and ponds, the western painted turtle uses mostly aquatic habitat types except for nesting. Occupied sites include river backwaters, river islands, and overflow ponds or they may be extensive wetland systems, large ponds, shallow lakes, and marshes. Sites have warm water and little shade. Water depths vary but often exceed 15 feet in some parts of the site. Typically, these sites have limited areas of tall emergent vegetation, such as cattail (*Typha latifolia*) and bulrush (*Scirpus acutus*), that may impede the turtles' underwater movements as well as their view of approaching predators. Aquatic vegetation is usually dense in sections of the water body, providing food directly and as a substrate for prey species. Hatchlings use the shallowest, sunniest parts of a site, often a small bay on a north shoreline that is sheltered from wind and has abundant small aquatic plants. Dense mats of aquatic plants, including patches of pond lily (*Nuphar polysepalum*), are used by turtles for basking, although the preferred basking sites for adults are partially submerged logs. Shoreline dirt and especially rock ledges are also used for basking. Females choose nest sites on land, up to 500 feet from water, where soil is somewhat sandy, there is little or no shade, and vegetation is not thick enough to hinder movement. Western painted turtles do not travel far during the year and hibernate at the bottom of the pond or river. (Nussbaum et al. 1983; Storm and Leonard 1995; Blood and Macartney 1998; and St. John 2002).

Distribution in the Sandy River Basin

The only known population of western painted turtles in the Sandy River Basin is at the Sandy River delta, where good habitat is provided by marshy ponds with logs from adjacent riparian forests and sunny, grassy meadows for nesting sites. Although no formal surveys have been conducted since 1992, turtles are still present in the ponds, the slough, and along the river near its mouth (Salix Associates 1992; Beilke 2005). Reproduction is still occurring, but in 2004, several depredated nests were found near the small ponds south of the slough (Barnes 2005). Individual turtles are occasionally seen further up the Sandy River—for instance in a human-made pond near Marmot—may be released pets (Corkran, unpublished data).

Northwestern Pond Turtle (*Emys* [= *Clemmys*] *marmorata marmorata*)

Species Status

The northwestern pond turtle is classified as a federal Species of Concern and a Sensitive – Critical species in Oregon (ODFW 2005c). Habitat loss, lack of recruitment because of high predation rates from raccoons and from introduced warm-water fish and American bullfrogs, and pneumonia epidemics that are probably related to pollution and other anthropogenic stressors are factors in the declining populations of this species (Holland 1994; Oregon Natural Heritage Information Center 2003; NatureServe 2005).

Life History

The northwestern pond turtle lays its eggs in terrestrial nests and spends its life in both aquatic and terrestrial habitats. Mating probably occurs in early spring. Females lay 1—13 hard-shelled eggs in mid-summer, after building up yolk reserves by foraging and basking. Each female leaves the water and lays eggs in a hole dug with the back legs, and partially plugs the hole with dirt and vegetation using the back legs and plastron (lower shell). The eggs hatch in late summer or fall, but at the northern end of their range most or all hatchlings remain in the nest until early the following spring, when they move to water. Hatchlings eat a variety of small invertebrates; adults also eat some aquatic plants, particularly pond lily seedpods, and carrion. Turtles forage by swimming slowly along the bottom or near the bank. Because basking is important for thermoregulation, prevention of skin diseases and parasites, and egg production in females, all ages of turtles spend many hours a day at it. If a potential predator is noticed, they dive suddenly from the surface or off of basking sites and swim rapidly to the bottom. Predators of larger juveniles and adults include terrestrial and semiaquatic mammals and birds. Females reach sexual maturity in 8 to 12 years; males are probably similar. In northern Oregon, females usually lay eggs only every other year. Pond turtles may live to be 40 years old, and some individuals apparently reach 50 years. (Nussbaum et al. 1983; Holland 1994; Storm and Leonard 1995; and St. John 2002.)

Habitat Needs

Predominantly occurring in California and southwestern Oregon, the northwestern pond turtle's range includes the Willamette Valley and adjacent Columbia River lowlands, with relict populations on both sides of the eastern Columbia Gorge. It occurs at elevations from near sea level to about 4,000 feet, but only to about 1,000 feet at the northern edge of its range (Holland 1994; Storm and Leonard 1995; St. John 2002).

Utilizing a variety of river and pond habitats, the northwestern pond turtle also makes extensive use of nearby terrestrial areas. Primary use areas include slow rivers and side channels, oxbow ponds, large wetlands, large ponds, and groups of smaller ponds. Low-gradient streams are often used in the southern part of their range. Deep, permanent water bodies, as well as shallow and ephemeral ones, are used, but all have full sun and warm water. Typical occupied areas have abundant basking sites, including logs, rocks, and mats of emergent vegetation, although tall emergent vegetation usually occurs in limited sections of the site. Aquatic vegetation is usually dense in some sections, providing food directly and as a substrate for prey species. Hatchlings use the shallowest, sunniest parts of a site, often a small bay on a north shoreline that is sheltered from wind and has abundant small aquatic plants. Females choose nest sites on land up to 1,300 feet from water, but more often 250 feet or less. Nest sites usually have clay soil, little or no shade, and vegetation is not thick enough to hinder movement. Northwestern pond turtles frequently hibernate in duff or soil in partially sunny locations as far as 1,600 feet from water, although in the northern part of the range some individuals hibernate at the bottom of the pond or river. Throughout the year, adults may move overland from one pond to another or change terrestrial hibernation sites during warm weather in mid-winter, so annual travel distances may exceed 0.5 mile. (Nussbaum et al. 1983; Holland 1994; Storm and Leonard 1995; St. John 2002.)

Distribution in the Sandy River Basin

There is no known population of northwestern pond turtles in the Sandy River Basin. Individuals of this species are occasionally seen in the Columbia Slough, although none have been reported from the Sandy River delta (Salix Associates 1992; Barnes 2005; Beilke 2005). Because this species travels fairly long distances, is often transported by people, and is wary and secretive in its behavior, it is possible that individuals do occur at the Sandy River delta.

5.6 Birds and Mammal

This HCP addresses two bird species and one mammal: the bald eagle, the northern spotted owl, and the fisher. When available, the following information is provided for each species: species status, life history, habitat needs, threats to survival, and distribution in the Sandy River Basin.

5.6.1 Birds

Bald Eagle *(Haliaeetus leucocephalus)*

Species Status

The bald eagle was removed as a threatened species from the federal list of endangered species on July 9, 2007 (USFWS 2007a), but is still listed as a threatened species in Oregon (ODFW 2005). Under the former federal and current state ESA regulations, habitat protection and management actions to protect nest sites and communal foraging and roosting areas have improved bald eagle reproduction and have enabled the population to expand. The City has used the National Bald Eagle Management Guidelines (USFWS 2007b) to guide its preparation of the bald eagle measures in the HCP.

Life History

Bald eagles reach maturity at 4-plus years of age, but may not enter the breeding population in denser populations until they are 6 or 7 years old (Gerrard et al. 1992, in Buehler 2000; Buehler 2000). The breeding season extends from January through August in Oregon (Isaacs et al. 1983). Nest initiation begins in February, with incubation starting in early March (Isaacs et al.983). Young hatch from early April to late May and fledge from mid-June to mid-August (Isaacs et al. 1983). Bald eagles generally lay one to three eggs, two being most common. Occasional four-egg clutches have been reported (Stalmaster 1987; Buehler 2000).

Habitat Needs

The breeding range of the bald eagle extends from Alaska and Canada, south to California, Texas and Florida (Csuti et al. 1997; Buehler 2000). In western Oregon, the bald eagle is found in the Willamette Valley, along the Columbia River, on the coast, and along most major rivers in the southwestern portion of the state (Csuti et al. 1997).

Bald eagles typically nest in large, super-dominant trees in forested areas adjacent to large bodies of water and in areas not subject to intense human activity (Anthony et al. 1982; Anthony and Isaacs 1989; Watson and Pierce 1998; Stinson et al. 2001). Douglas-fir (*Psuedostuga menziesii*), Sitka spruce (*Picea sitchensis*), and western hemlock (*Tsuga heterophylla)* are used as nest trees in western Oregon (Anthony et al. 1982). Douglas-fir with a mean diameter at breast height (DBH) of 69 inches constitutes 74 percent of the nest trees. Nesting territories need to contain a number of alternate nest trees similar in size to the active nest tree to persist, because nests are known to last from 5 to 20 years and eventually need to be replaced (Stalmaster 1987; Stinson et al. 2001). In Oregon, 84 percent of nest trees were within one mile of permanent bodies of water, and all were within 4.5 miles (Anthony and Isaacs 1989). In western Oregon, bald eagles are known to nest up to 5,500 feet in elevation (Isaacs and Anthony, unpublished data cited in Isaacs and Anthony 2003).

Foraging habitat consists of large areas of open water with fish and waterfowl populations that are available to eagles (Buehler 2000). Areas used most often are in the vicinity of foraging perch trees (Stalmaster 1987; Stinson et al. 2001). Stalmaster (1987) reviewed bald eagle food habits from across North America and found that fish make up 56 percent of the diet, while birds and mammals make up 28 and 14 percent, respectively.

Many bald eagles congregate at communal winter roosts in areas of abundant prey. Winter roost use is primarily influenced by the abundance and distribution of prey and only secondarily influenced by roost characteristics (Watson and Pierce 1998). Bald eagle winter roosts have been shown to provide more favorable microclimates than are generally available in the vicinity (Stalmaster 1981, cited in Stinson et al. 2001; Knight and Knight 1983; Keister et al. 1985; Stellini 1987, cited in Stinson et al. 2001). Microclimate conditions are a result of tree structure and topographic location. Stands with the largest and most decadent trees are most often used for roosting (Stinson et al. 2001).

Threats to Survival

Bald eagles are known to be sensitive to human disturbance, though they are believed to become habituated to, or learn to tolerate, regular human activity (Stalmaster and Newman 1978; Knight and Knight 1984; Anthony and Isaacs 1989; Stalmaster and Kaiser 1997). Experimental pedestrian disturbance indicates that restricting human activity within 394 feet of nests and providing high levels of visual screening around nests would be most effective at minimizing the effects of disturbance (Watson and Pierce 1998). In general, a bald eagle's response to human disturbance increases inversely with distance to the disturbance and increases with the duration of a disturbance, the number of vehicles or persons at the disturbance, visibility, and sound (Grubb and King 1991).

Nest success has been found to be related to disturbance levels. Unsuccessful nests received twice the rate of disturbance from pedestrians, aircraft, and total human activities than did successful nests (Watson and Pierce 1998). The presence of homes within 197 feet of nests was correlated to passive pedestrian activity (e.g., nonaudible) and found to be the only human factor to reduce time spent in incubation (Watson and Pierce 1998). However, a number of studies from across the country have documented bald eagles in developed areas showing signs of adapting to human activity (Grubb et al. 1992; Watson et al. 1999; Stinson et al. 2001).

Wintering bald eagles can be displaced by human activity for up to 30 minutes following the activity (Stalmaster and Newman 1978; Skagen 1980; Knight and Knight 1984). Disturbance response decreases with increasing distance from the disturbance. Stalmaster and Kaiser (1997) found 61 percent of bald eagles flushed in response to boat disturbance along a river, but they generally tolerated the discharge of firearms within 0.3 to 3.7 miles.

Temporary disturbances and habitat modification do not necessarily result in winter roost abandonment. Timber harvest adjacent to communal roosts and partial harvest within roosts did not alter the number of eagles using the roost in subsequent years, but logging activities did cause the eagles to leave the roost each day at an earlier time than normal (Hanson et al. 1980).

Although raptors are not generally considered at high risk of collision with power lines (Hunting 2002a), bald eagles are known to have been harmed or killed by electrical power lines from collisions with overhead wires and electrocution. Factors that may increase their risk of collision with power lines include adverse weather conditions that may reduce visibility and placement of power lines near communal roost areas (Steenhof and Brown 1978, cited in Hunting 2002a). A review of 4,300 bald and golden eagle carcasses from the early 1960s through the mid-1990s found electrocution was the fourth leading cause of death for bald eagles (12 percent of deaths due to electrocution); accidental trauma (collision with vehicles, power lines, or other structures) was the most common cause in both species (Franson et al. 1995). Harmata et al. (1999) banded bald eagles in the Greater Yellowstone Ecosystem and found that 20 percent of the 49 birds recovered had died of electrocution or collisions with power lines. Olendorff et al. (1989, cited in Herbert et al. 1995) did not consider collision mortality among raptors to be a primary cause for population decline, except in a critically endangered species like the California condor.

Bald eagles are more susceptible to electrocution than to collisions when compared with other birds, due to their large size and ability to avoid collisions in flight (Bevenger 1994, 1998). The risk of avian electrocution is greater for power lines of low to medium voltage (less than 69 kilovolts) because the distances between energized conductors decrease with voltage, thereby increasing the potential for the birds to span the distances with their wings increases (Avian Powerline Interaction Committee 1996, cited in Hunting 2002b; Dorin et al. 2005). Juvenile birds make up a high percentage of raptor electrocution mortality (Miller et al. 1975, cited in Herbert et al. 1995; Nelson and Nelson 1976, cited in Herbert et al. 1995; Ledger et al. 1987, cited in Herbert et al. 1995; Harness and Wilson 2001). Harness and Wilson (2001) examined 1,428 electrocuted birds and found 66 percent of eagles were juveniles.

Power pole design can influence raptor mortality from electrocution. Dwyer and Mannan (2004, cited in Dorin et al. 2005) found electrocution of Harris' hawks declined from 1.3 to 0.3 electrocutions per nest after poles were retrofitted with raptor safe hardware. However, design modifications may need to be site-specific to be effective. Ferrer and Hiraldo (1991) found that installing raised perches did not alter mortality rates for the Spanish imperial eagle in Spain, while converting danger lines to isolated cables or buried lines increased juvenile survival from 18 to 81 percent.

Distribution in the Sandy River Basin

There are no known bald eagle nest sites in the Bull Run Management Unit, though bald eagles are periodically reported around the reservoirs (Oregon Natural Heritage Information Center 2004; Isaacs 2006; Robbins 2006). One active bald eagle nest is located along the Bull Run River downstream of the management area (Oregon Natural Heritage Information Center 2004; Isaacs and Anthony 2004). The bald eagles at this site unsuccessfully nested from 2002 through 2004. The bald eagle pair successfully nested for the first time in 2005 (Isaacs 2006). There are no known winter communal roost areas in the Sandy River drainage.

PGE does not have any records of bald eagle collisions or electrocution along the power lines in the Bull Run drainage (Marheine 2006).

Northern Spotted Owl *(Strix occidentalis caurina)*

Species Status

The northern spotted owl is a state and federally listed threatened species (ODFW 2005). The primary threats to the spotted owl identified in the federal listing were the loss, modification, and fragmentation of habitat (USFWS 1990).

A recent demographic analysis of spotted owl populations in the Warm Springs and H. J. Andrews demographic study areas (the two closest demographic study areas to the Sandy River Basin) found stable fecundity rates and no significant trend in apparent survival (Anthony et al. 2004). However, there was strong evidence of a population decline through time. When the 13 demographic study areas from across the range of the species were combined, there was a 3.7 percent annual rate of decline. The analysis indicated the rate of change may not be as high on federal lands. The eight demographic study areas that are part of the monitoring program for the Northwest Forest Plan showed an annual decline of 2.4 percent, compared to 5.8 percent for the other areas (Anthony et al. 2004).

Life History

Spotted owls may occasionally breed their first year, but reproductive success is very low for birds less than two years old (Miller et al. 1985, cited in Gutiérrez et al. 1995; Anthony et al. 2004). Eggs are laid in March and April (mean initiation date for Oregon is April 2; range is March 9 to April 19) (Forsman et al. 1984; Gutiérrez et al. 1995). The limited information available on clutch size indicates two-egg clutches are most common, but clutch size can range from one to four eggs (Bendire 1892 and Dunn 1901, both cited in Gutiérrez et al. 1995; Gutiérrez et al. 1995). Incubation averages 30 days, and young fledge from the nest when they are about 34 to 36 days old, usually from mid-May through the end of June (Forsman et al. 1984; Gutiérrez et al. 1995). By September or October, the young reach an adult weight and disperse from the natal area (Gutiérrez et al. 1985; Miller 1989).

Habitat Needs

The spotted owl is a permanent resident of the temperate conifer forests of the Pacific Northwest, ranging from southern British Columbia through Washington and Oregon to northern California, along the Cascades and coastal mountain ranges (USFWS 1990).

Spotted owls are forest dwellers. They use a variety of conifer dominated forest types for nesting in the Pacific Northwest (Gutiérrez et al. 1995). Nests are generally in mature, old forest stands having more forest structure and complexity than random sites (Forsman et al. 1984; Solis and Gutiérrez 1990; Carey et al. 1990 1992).

Spotted owls nest frequently in Douglas-fir trees in western Oregon Cascades (87 percent) and the Oregon Coast Range (93 percent), while on the Olympic Peninsula nesting is more evenly distributed among western hemlock, Douglas-fir, and western red cedar (Hershey et al. 1998). In western Oregon, the mean DBH for trees with cavity nests was 53 inches and for those with platform nests was 42 inches (Forsman et al. 1984). All nest trees (live and dead) on the Olympic Peninsula had a mean DBH of 54 inches (Forsman and Giese 1997).

Nests can be in cavities or on platforms. Cavities used for nesting can form where a limb or the top of a tree has broken off (Forsman et al. 1984; Buchanan et al. 1993; Forsman and Geise 1997). Platform nests can be placed on mistletoe brooms, on platforms created by multiple leaders, on healthy limbs, or on structures constructed by other birds or mammals (Forsman et al. 1984; Buchanan et al. 1993; Forsman and Geise 1997). The majority of nests (80 to 94 percent) in northern California, the western Oregon Cascades, the Oregon Coast Range, and the Olympic Peninsula were placed in top or side cavities, compared to only 16 percent cavity nests in the eastern Washington Cascades (Forsman et al. 1984; Buchanan et al. 1993; Forsman and Giese 1997; Hershey et al. 1998).

Spotted owls appear to use a wider variety of forest conditions for foraging than for nesting or roosting (Thomas et al. 1990). Foraging habitat consists of forest stands with a high canopy closure and complex forest structure (Gutiérrez et al. 1995). Mature and old-growth stands were selected for perching outside the breeding season in western Washington (Herter et al. 2002). Roost stands were dominated by trees with a DBH greater than 20 inches and a canopy closure of 60 percent. Studies in western Oregon, the Klamath Province, and northern California also found older forests were used for perching more frequently than was expected (Carey et al. 1992; Tanner 1999, cited in Courtney 2004; Irwin et al. 2000). Modeling of demographic performance in Oregon found a mix of mid- and late-seral forest with younger forest and nonforest to be best for spotted owl survival and reproduction, although the authors suggest further study is required due to the low variability in survival and productivity attributed to habitat (Olson et al. 2004).

Threats to Survival

Habitat loss and fragmentation were the primary threats to the northern spotted owl when it was listed (U.S. Department of Interior 1990). The rate of harvest from 1994 to 2003 on federal land was lower than projected at the time of listing, due to the Northwest Forest Plan (U.S. Department of Interior 2004, cited in Courtney et al. 2004). However, suitable spotted owl habitat is estimated to have declined range wide by 5.14 percent on federal lands from 1994 to 2003 (U.S. Department of Interior 2004, cited in Courtney et al. 2004). The majority of the decline (3.03 percent) was a result of natural events (e.g., wildfire), while 2.1 percent was from management activities. There is insufficient information available to estimate a trend in suitable habitat on nonfederal land (Courtney et al. 2004).

While spotted owls have been known to be injured or killed by shooting and collisions with vehicles (Gutiérrez et al. 1995), they do not appear to be particularly sensitive to human disturbance. Human contact during research was not found to negatively impact spotted owls (Gutiérrez et al. 1995).

Photo courtesy of Char Corkran.

A significant amount of attention has been paid recently to the potential threat that the barred owl (*Strix varia*) presents to the spotted owl. The barred owl has been expanding its range in the Pacific Northwest over the last 50 years, and it is now sympatric with the northern spotted owl throughout most, if not all, of its range (Kelly 2002; Kelly et al. 2003; Courtney 2004). The full effect of barred owl presence on the spotted owl population is not known, but there is a concern about competition, particularly competition that leads to displacement, and, to a lesser extent, hybridization. A third, minor concern is fighting or threatening behaviors that may lead to barred owls killing spotted owls. There is some circumstantial evidence that barred owls may periodically kill spotted owls (Leskiw and Gutiérrez 1998), but the extent to which this may occur is unknown.

Competition between barred owls and spotted owls may occur at the level of resource use and may extend to territorial displacement. Compared with the spotted owl, the barred owl is more of a habitat and dietary generalist. The ability of the barred owl to occupy younger conifer and mixed forests may allow it to become established in regenerating forest landscapes prior to the spotted owl. While the barred owl utilizes a wider array of prey species, Hamer et al. (2001) found that the diets of barred owl and spotted owl have a 76 percent overlap. When availability of prey used in common by spotted owls and barred owls is limited, the ability of the barred owl to use a wider variety of prey may provide it a competitive advantage.

Competition could lead to barred owls displacing spotted owls from otherwise suitable habitat. Pearson and Livezey (2003) found significantly greater numbers of barred owls in proximity to unoccupied spotted owl site centers than to occupied site centers. A number of authors report barred owls replacing spotted owls in established territories (Sharp 1989; Dark et al. 1998; Kelly et al. 2003). However, most of the studies relied on the results of survey information and do not indicate whether the sites were abandoned by spotted owls prior to barred owl occupancy, were actively displaced by agonistic behavior, or were still in the area and simply went undetected because of reduced vocalization. On the Olympic Peninsula, spotted owls were confirmed to have moved 2,461 feet when barred owls were found in the vicinity of a site center previously occupied by spotted owls (Gremel 2000).

Anthony et al. (2004) considered the effects of barred owl presence on spotted owl fecundity and apparent survival. In general, barred owls were not found to have an effect on spotted owl fecundity, though there was a negative effect recorded for the Wenatchee and Olympic Peninsula study areas. Barred owl presence impacted apparent spotted owl survival in three Washington demographic study areas, but it did not influence apparent survival in the Oregon study areas. More than 50 cases of hybridization between spotted and barred owls were recorded from 1974 to 1999, and while the extent of hybridization is not known, the rate appears to be low (Courtney 2004). Herter and Hicks (2000) did not document any hybridization in their Central Washington Cascade study area from 1991 to 1993, even though barred owls were well established in the area by that time. Hybridization was not generally considered to be a significant threat by the panel convened for the five-year review of the status of the northern spotted owl (Courtney 2004). In situations where a population is very low, the panel thought hybridization could exacerbate the problem, but demographic processes would have more influence on the population.

Spotted owls do not seem to be as sensitive to human activity as some other avian species. Direct human contact during research activities has not been found to negatively impact spotted owls, and hiker disturbance trials did not alter the energy budget of Mexican spotted owls inhabiting canyons (Gutiérrez et al. 1995; Swarthout and Streidl 2003). Spotted owls have been recorded as being harmed or killed by shooting and collisions with vehicles. While the extent of this type of mortality is unknown, it is thought to be low (Gutiérrez et al. 1995).

Two studies have looked at the Mexican spotted owl’s response to aircraft and chainsaws. During five-minute trials with helicopters and chainsaws, no spotted owls flushed when the disturbance stimuli were at least 345 feet from the owl (Delaney et al. 1999) and only two of the 22 recorded flushing events (9 percent) were at distances over 197 feet. There was some indication during this study that spotted owls may have been habituating to the treatments, but the sample size was not large enough for statistical testing. Johnson and Reynolds (2002) observed spotted owl behavior during overflights of military fixed-wing aircraft. Trials consisted of three consecutive overflights at progressively faster and louder passes. Spotted owl behavioral response during the trials did not exceed the 10 minute pre- and post-treatment periods.

Distribution in the Sandy River Basin

As of 1997, there were 49 resident spotted owl sites within the Sandy River Basin, including one on City lands and 21 on USFS lands within the Bull Run watershed (Robbins 2006). Of the 21 sites on USFS lands in the Bull Run, seven are within 1.2 miles of City lands. Most of these sites were located during a two-year survey conducted in 1993 and 1994; current status of the sites is unknown. A search of the Oregon Natural Heritage Information Center database identified three additional spotted owl sites in the upper Sandy River Basin outside the Bull Run watershed (Oregon Natural Heritage Information Center 2004).

5.6.2 Mammal

Fisher *(Martes pennanti)*

Species Status

The West Coast DPS of the fisher is listed as a candidate for federal listing (USFWS 2005). The USFWS 12-month findings found listing of the fisher to be warranted but precluded (1994).[11] The principal threats to the DPS are related to isolation of populations and continued fragmentation of suitable habitat. The fisher also is listed as Sensitive - Critical in Oregon (ODFW 2005).

Life History

Female fishers can breed by one year of age (Douglas and Strickland 1977; Eadie and Hamilton 1958; Hall 1942, all cited in Powell 1993; Wright and Coulter 1967). Breeding occurs from February to April (Csuti 1997). Fishers give birth in late March and early April (Mead 1994; Aubry and Raley 2002), and females will mate approximately one week after parturition (Powell and Zielinski 1994). Young are born almost a year after fertilization, following about 10 to 11 months of delayed implantation (Csuti 1997). Litters range from one to six kits; average is about 2.7 (Powell 1993). Juvenile fishers dispersed and established their own territories by one year of age (Arthur 1987 and Paragi 1990, both cited in Powell 1993). The female fisher and young leave the natal den when the young are about eight weeks old (Leonard 1980, cited in Powell 1993). The upper limit for life expectancy in the wild is estimated to be about 10 years of age (Powell 1993).

Habitat Needs

The fisher is found across Canada and the United States, from New England, the upper Midwest, northern Rockies, and the western mountains, south to the Sierra Nevada in California (Csuti 1997). The range of the fisher includes southwest Oregon, the south half of the Cascades, and northeastern Oregon (Csuti 1997). Fishers have been most commonly associated with low to mid-elevation forests in the Pacific states, up to 8,200 feet (Grinnell et

[11] "Warranted but precluded" status indicates that the data submitted with the petition to list the species under the ESA support the need to list the species, but other species are of higher priority. Section 4(b)(3)(B) of the ESA directs the federal agency that makes a "warranted-but-precluded" finding to review the petition annually to reassess the petition.

al. 1937, and Schempf and White 1977, both cited in Powell and Zielinski 1994; Aubrey and Houston 1992).

Fishers are associated with older, closed-canopy forests with abundant large coarse woody features (snags and logs) and understory vegetation (Buck et al. 1983, cited in Lewis and Stinson 1998; Arthur et al. 1989b; Jones 1991; Powell 1993; Seglund 1995). In the Pacific Northwest, fishers are more frequently found in late-successional forests than in early- to mid-successional forests resulting from timber harvest (Aubry and Houston 1992; Buck et al. 1983, cited in Powell and Zielinski 1994; Buck et al. 1994; Raphael 1984, cited in Powell and Zielinski 1994; Rosenberg and Raphael 1986).

Natal dens are most often elevated cavities in snags or trees (Buck et al. 1983, cited in Lewis and Stinson 1998; Weir 1995, cited in Lewis and Stinson 1998; Zielinski et al. 1995, cited in Lewis and Stinson 1998; Aubry et al. 1996, cited in Lewis and Stinson 1998; Paragi et al. 1996; Aubry and Raley 2002), but occasionally logs and rock formations are used. The mean height of 12 natal den openings in the southern Oregon Cascade Range was 53 feet; range was 13 to 153 feet (Aubry and Raley 2002).

Maternal dens have been located in a variety of tree species in the West, including quaking aspen (*Populus tremuloides*), black oak (*Quercus kelloggii*), black cottonwood (*Populus balsamifera*), incense cedar (*Calocedrus decurrens*), Douglas-fir, (*Pseudostuga menziesii*), white and grand fir (*Abies concolor and grandis*), pine (probably *Pinus ponderosa and P. monticola)*, and golden chinquapin (*Castanopsis chrysophylla*) (Buck 1982; Weir 1995; Zielinski et al. 1995; Aubry et al. 1997, all cited in Lewis and Stinson 1998; Aubry and Raley 2002). Trees and snags with natal and maternal dens have been found to range in DBH from 21 to 56 inches (Buck 1982; Weir 1995; Zielinski et al. 1995; Aubry et al. 1997, all cited in Lewis and Stinson 1998; Aubry and Raley 2002). Fisher kits may be moved to as many as five maternal den sites (Paragi et al. 1996). Maternal den sites may be near the ground or high in a tree and snag (Aubry, pers. comm., cited in Lewis and Stinson 1998).

Fishers tend to forage in habitats or microhabitats with high densities of prey (Powell 1977, cited in Powell and Zielinski 1994). Since food habit studies have not been conducted in the West for fisher, it is assumed that snowshoe hare habitat (a common prey species of fisher in other areas of the country) constitutes suitable foraging habitat (Lewis and Stinson 1998). In the Pacific Northwest, the range of the snowshoe hare is consistent with the original range of the Douglas-fir forest.

Fishers generally use structures in large standing live trees and snags for rest sites rather than sites on the ground (Buck 1982; Jones 1991; Seglund 1995; Weir 1995; Zielinski et al. 1995; Aubry et al. 1997; Zielinski et al. 2004). Live tree and snag structures used for resting include cavities, witches' brooms, mistletoe clumps, large lateral limbs, squirrel and woodrat nests, stick nests, and forks. Ground rest sites include logs and root-wads, log or slash piles, stumps, rock outcrops, subnivean and ground burrows, and vegetation thickets.

The largest available trees (most often over 39 inches DBH) are selected for rest sites (Zielinski et al. 2004). In the north Coast Range of California, 66 percent of rest sites were in Douglas-fir trees. Live conifer and conifer snags were the largest trees used for rest sites, having mean DBH of 46 inches and 47 inches, respectively (Zielinski et al. 2004).

Life History

Fisher have been found to avoid areas with low canopy cover and large forest openings, including those created by clearcuts (Buck et al. 1983, cited in Lewis and Stinson 1998; Arthur et al. 1989b; Powell 1993; Buskirk and Powell 1994; Jones and Garton 1994, cited in Lewis and Stinson 1998; Weir 1995, cited in Lewis and Stinson 1998). The fisher's avoidance of open habitats has affected local distribution and population expansion (Coulter 1966 and Earle 1978, cited in Powell and Zielinski 1994). Low- and mid-elevation forests are now younger, have reduced amounts of course wood, are fragmented, and may not be capable of supporting fishers (Rosenberg and Raphael 1986; Lyon et al. 1994; Powell and Zielinski 1994).

Fishers tend to avoid humans and are seldom seen, even where abundant (Douglas and Strickland 1987; Powell 1993); however, fisher may not be as sensitive to human disturbance as once thought (Johnson and Todd 1985). Maternal dens were found on a few occasions in the Northeast within a few yards of utilized roads, and harvest activity within 16 feet did not result in the den being moved (Powell et al. 1997). In Oregon, fisher movements are not hindered by unpaved logging roads, but home ranges are not maintained on both sides of paved roads (K. Aubry, pers. comm., cited in Lewis and Stinson 1998).

Fishers are known to occasionally use habitat near low-density housing, farms, and roads, and they even den under occupied structures (Pittaway 1978, cited in Lewis and Stinson 1998; Johnson and Todd 1985; Arthur et al. 1989a; Jones 1991, cited in Lewis and Stinson 1998). Fisher in New England may be adapting to live near humans, since they now inhabit suburban areas (W. Krohn, pers. comm., cited in Lewis and Stinson 1998). However, human disturbance at or near the den may result in the litter being moved to a new den (Paragi 1990, cited in Lewis and Stinson 1998).

Distribution in the Sandy River Basin

There are no recent records of fisher in the Sandy River Basin (Oregon Natural Heritage Information Center 2004). The closest known fisher population is in the south and central Oregon Cascades, north into southern Linn County (Csuti et al. 1997). Fishers are not expected to be present in the Sandy River drainage.